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THE GEOGRAPHICAL JOURNAL

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NOTICES

SESSION 1927–1928.

The following are the Dates for the Evening and Afternoon Meetings of the Session.

EVENING MEETINGS at 8.30 p.m. ÆOLIAN HALL.	AFTERNOON MEETINGS at 5 p.m. MAP ROOM, Lowther Lodge.
Monday, November 7 and 21	Monday, November 14
December 5 and 19	December 12
January . 9 and 23	January . 16
February 6 and 20	February 13
March . 5 and 19	March . 12 and 26
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At the first meeting of the session on November 7 Doctor Lauge Koch will read a paper on his recent journey on the East Coast of Greenland. A full programme for the early part of the session will be published in the November *Journal.*

LIST OF FELLOWS, 1927. A new list of Fellows, corrected up to 30 September 1927, will be published in November. Those Fellows who wish to receive the list free of charge should notify the Chief Clerk by October 20.

PHOTOGRAPH ROOM. The attention of Fellows is called to the water-colour sketches of Asia Minor, Syria, and 'Iraq made by Mr. Lionel Muirhead between 1868 and 1870 now exhibited.

THE SOCIETY'S HOUSE. The House is open on week-days from 10 a.m. to 6 p.m.

By Order of the Council,
ARTHUR R. HINKS,
Secretary.

The object of the Society being the Promotion and Diffusion of Geographical Knowledge, it has always welcomed to its Fellowship those anxious to further this object by their interest and support, as well as those able to take a more active part in the work of discovery and exploration.

Candidates for admission into the Society must be proposed and seconded by Fellows, and it is necessary that the description and residence of such Candidates should be clearly stated on their Certificates.

It is provided by Chapter V., § 1, of the Bye-Laws, that—

"Every Fellow shall, on election, be required to pay £5 as entrance fee, and £3 as annual subscription for "the current year, and thereafter a yearly contribution of £3, due on the 1st January of each year; or he may "compound either at entrance by one payment of £45, or at any subsequent period on the following scale, "provided that there shall be at the time no arrears due by him to the Society:—

Fellows of 10 years' standing and under 15	£30
15 " " " 20	£24
20 " " and over	£18 15s.

"No Fellow shall be entitled to vote or to enjoy any privilege of the Society while in arrear. Honorary "and Honorary Corresponding Members and Fellows elected under Chapter III., Paragraph 5, are not required to "make any payments."

All subscriptions are payable in advance, on the 1st of January in each year.

The privileges of a Fellow include admission (with one Friend) to all ordinary meetings of the Society, and the use of the Society's House, Library and Map-room. Each Fellow is also entitled to receive a copy of all the Society's Periodical Publications.

The Geographical Journal

Vol. LXX No. 4 October 1927

THE COUNTRY OF THE BALUBA IN CENTRAL KATANGA

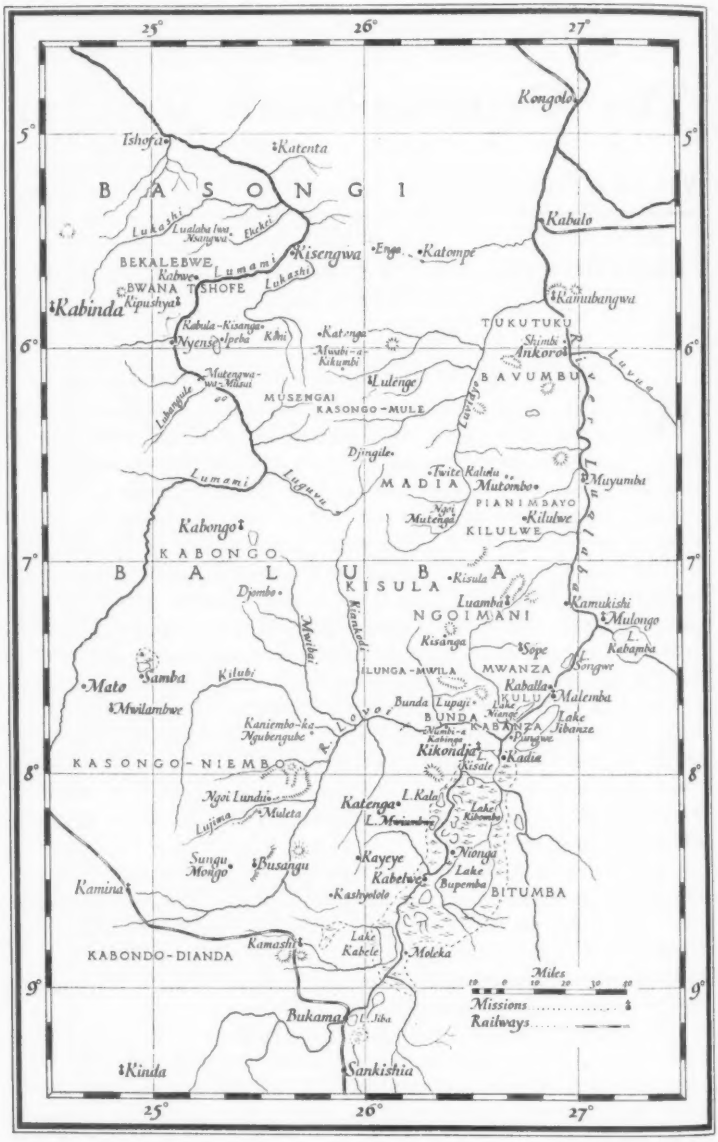
W. F. P. Burton

Read at the Meeting of the Society, 30 May 1927

WITHIN the last few years the Cape-to-Cairo Railway route has reached and passed the Congo at Bukama, and thousands of people travel through the Katanga, from Cape Town *viâ* Elizabethville, from Dar-es-Salaam *viâ* Albertville, or from Boma up the Congo River. These travellers move so comfortably along the main routes that there is no incentive to leave the beaten track, and thus the "hinterland" is little known, even a short distance from the river and railway, excepting to the few officials, traders, miners, and missionaries who are on the spot. Several writers, after a few weeks' journey through the country, have produced books in which they describe river travel, modern townships, and Europeanized natives. They have failed to recognize that they have not touched the real country or the real people. The few white men living in that part of the country are too much occupied with tax-collecting, tin-mining, or trading to worry about preparing maps. All existing maps that I have seen in print leave big blank spaces in Lubaland, with a few misleading names to mystify further. As a matter of fact there are villages scattered everywhere.

In 1915 I went to the Katanga with three companions, to commence evangelization from a centre at Mwanza, and the work has gradually spread till to-day we have twenty-five white missionaries and 120 native evangelists at work in the country which has its south-eastern corner at Bukama, the place where the Katanga Railway reaches the highest navigable waters of the Congo system.

The Country of the Baluba.—The country shown in the accompanying sketch-map is drained by the rivers Lualaba and Lomami. The most important tributaries to this section of the Lualaba are the Lufira, Lovoi, Kalumeñongo, Luvua, and Luvidyo. The part of the Lomami under consideration is fed by the Luguvu, Lubangule, Lukashi, and a number of smaller streams. At Bukama the Lualaba is about 2270 feet above sea-level, falling so gradually that navigation is possible from there



Sketch-map of the country of the Baluba, Central Katanga

to Kongolo. Navigation is also possible for some distance up the Lufira and Luvua, but the sleeping-sickness fly and the small population prevent full advantage being taken of either river. The Luvidyo is effectually blocked by rocks at Shimbi, and the Lovoi near Bunda, though at the end of the rainy season large canoes can mount the latter as far as Numbi-a-Kabinga.

There is a great contrast between the Lomami and the Lualaba, or whereas the former runs for the greater part between rocky hills, over a shallow stony bed, and with forests down to the water's edge, the whole of this stretch of the Lualaba was evidently once a great lake, and to-day there are several large and small lakes at the sides of the river and only separated from it by narrow banks, while the Lualaba actually flows right through Lake Kisale. These lakes are linked up by great open plains, which are more or less inundated from December till June.

The highlands rise in many places almost abruptly from the level of the plains to an undulating country of from 2500 to 3300 feet above sea-level. In much of the Kasongo-Niembo and Kabongo region the average altitude is roughly 3000 feet above the sea, and a similar altitude is found in the Kasongo-Mule region and Mwabi region. The highest spots in all this region are about Kamina, Madia, and the Koni lakes (Kabula Kisanga).

A part of the south of the Kasongo-Niembo Territory maintains an altitude of about 3400 feet from Kaniembo ka Ngubengube to Sungu Monga, excepting where an occasional rocky hill such as Bunda or Nyenga-Ntengu juts out abruptly or where a river has worn a deep course through the country. Between Ngoi Lundu and Mulela the Lujima has worn a valley 5 miles across and over 1000 feet deep; but the altitude of the flat land to the east and west of this valley is almost exactly the same. The highlands fall somewhat abruptly to the Lovoi plains, 400 to 600 feet below.

In the neighbourhood of Kasholoło, and from Djingile up to the country about Kisengwa, there are patches of exceedingly dense forest, with rubber vine in places. Most of the high country, however, is covered with open forests or park-like lands, in which one can see from 50 to 200 or 300 yards through the trees, excepting when the long grass of the rainy season shuts out the view. Some parts are great rolling plains up to where thick forest follows the course of the streams. Such open country obtains from the Lubangule River northward beyond the Ekekei, and from there eastward to Katanga-Mukombo and the Bene Musengai, as well as over much of the Kabongo and Kasongo-Niembo Territories.

Climate.—In the area shown in the map the seasons are fairly constant from year to year. At Mwanza the rains continue from about September 23 to about May 11, with often a few rainless weeks in February or early March. At Ankoro the rains often start a fortnight before those of Mwanza, and among the Bekalebwe some three weeks before. It is

strange that to the east of the Kikondja hills there is very little rain. Often it only falls sparsely between December and March, though only a few miles away on the other side of the hills they enjoy the usual six months of rain. In the early part of the rainy season much of the rain falls in the afternoon, so that the natives are able to do a good morning's gardening before it starts. I have no rain-gauge, but should judge that the fall is between 50 and 60 inches per year. The rains are often accompanied by tremendous electric storms. Kabinda has a specially bad reputation in this respect, and almost every year some person or building is struck. From June till September there is usually no rain at all, though sometimes one or two untimely showers fall.

Occasionally during the rainy season there are rainless wind-storms of extraordinary violence. The eastern horizon assumes a dull leaden grey. The roar of the wind is heard some minutes before it actually arrives. Every one rushes to take the pictures from the walls, and to weigh down with heavy articles anything which is likely to be otherwise damaged, and finally, as the storm arrives, every one runs into the open. Roofs are sometimes carried unbelievable distances, and huge trees are snapped like matches, though the path of most extreme violence of the wind is only a few yards wide. Fortunately, such storms are rare.

The temperature is by no means excessive. During the coldest month, June, the shade temperature may vary from 65° F. at night to 80° F. during the day; while during October, which is the hottest month, and specially hot if the rain is sparse, it may vary between 72° F. at night and 90° F. during the day. Down at Kikondja, which is nearly 600 feet lower, the temperature is about 5° F. higher; but at Kabondo Dianda, Kamina, and Busangu it is so much cooler that one needs a jacket after dark, and blankets on one's bed.

It is scarcely needful to point out that, while on a high dry hill, as at Mwanza, one hardly needs a blanket throughout the year, near the streams and undergrowth a few hundred yards away, one shivers under two heavy blankets, owing to the heavy evaporation of local moisture. The rocks and sun-baked earth on the hill absorb the heat during the day, giving it out at night, and thus equalizing the temperature.

Apart from the malaria I do not consider the country as a whole unhealthy. Several of our missionaries have wives and children in robust health, while there are men who have spent ten to fifteen years in the country without a break.

The Effect of the Rain on the Lakes and Plains.—The division of the year into roughly six months of rain and six months of dry naturally implies a corresponding difference in the river-level, and I have waded across the Congo river at Moleka in August where a heavily laden vessel could have passed only three months before. Here the lakes perform a very important function as equalizers of the Lualaba's level, for during the early months of the rainy season the waters, which would otherwise

Soswe peak and Kibara mountains from Katwevwe

Kilubi river, a tributary of the Lomami

Smelting iron at Kayeye

Weaving raphia cloth

cause a sudden rise of the river, pour instead into the lakes and over the plains. Then after the rainy season is over, instead of the Lualaba dropping in level immediately, these lakes and marshes drain back again into the river, keeping it more or less navigable through the dry season.

This function of the lakes is not without its drawbacks, for the rising waters set free immense rafts of papyrus, and as soon as the lakes are full thousands of tons of papyrus are borne back into the channel, blocking it to all traffic.

The outlet from Lake Kabamba is often blocked for some months, though this is of no serious consequence, as there is not much traffic through the outlet at any time. At the confluence of the Lufira and Lualaba in Lake Kisale, however, the matter is very different, for almost the whole of the traffic between Elizabethville and the lower Congo is sometimes barred for weeks at a time, occasioning the loss of millions of francs. This is specially serious since it occurs just at the end of the rainy season, when thousands of tons of maize and other produce are being taken up the river, to supply the native workers on the mines and railways.

The C.F.L. (The Chemin de fer des Grands Lacs, which does the greater part of the transport on the river) has driven rows of massive piles along the course of the Lualaba through Lake Kisale, and has linked these together with steel lines, to prevent the discharge of papyrus from the lake into the river; but this barrier is often broken through, while at exceptionally high-water levels, the papyrus floats over the restraining lines, so that the river still becomes blocked at times.

Products.—The greatest mineral wealth of this section of the Katanga seems to be the tin, worked by the Société Géological et Minière (Geomines) at Bunda, Mwanza, Lukanga, and Kulu. At present there are about a thousand natives employed, and the soil is washed from the tin ore on the usual long wooden sluices. Lack of water during the dry season has somewhat hindered the operations, but the introduction of modern machinery, including pumps, will gradually overcome this.

There is coal at Sankishia, and it is apparently better in quality as the shafts are sunk deeper. The natives extract sufficient iron, in the regions of Kayeye, Kilulwe, Kalulu, and Lualaba-lwa-Nsangwa, to make their own spears, hoes, axes, and knives.

There are salt deposits on the Kiankodi river, but the natives do not work these on anything like a commercial scale, so that only two or three days' journey away one still finds natives making their insipid salt from burnt reeds. It might interest to mention the great path, made entirely by wild animals on their way to lick the salt. This path runs for several days' journey to the salt marshes, and we have seen similar paths, not used by man, going to the Nanza and Nyembwa-Kunda salt-pans, from the highlands between the Lualaba and Lake Mweru (Moero). In

places where the anthill clay contains salt, anthills are sometimes half licked away by wild game.

The forests contain much splendid timber, and when a larger white population creates a greater demand for planks, there is no doubt that the 200 odd varieties already known, and other trees whose properties are still to be discovered, will be better appreciated than they are to-day. Already there has been much cutting of timber, but, specially about Kabinda neighbourhood, the deforestation is being wisely followed up by re-planting with Kalunga-muchi, a quick-growing and generally useful tree. Unfortunately, commercial exploitation of these valuable timbers is not feasible excepting in the areas of the copper-mines, owing to the great cost of transport to the coast.

Large tracts of forest are annually destroyed by the natives, who think nothing of cutting down and burning the most magnificent timber trees for the sake of a little potash for their maize cultivation. But destruction on a larger scale is wrought by the great forest fires, which sweep the country every year during the native hunts. The animals are enclosed in a great circle of burning forest, and are shot as they try to escape through the blinding flames and smoke. I passed through splendidly timbered country in 1916 and 1917, where to-day there is only insignificant and stunted underbrush left.

From Kabongo northward the natives make grass cloth from two varieties of raphia, and already the missions are teaching their children to make useful basketry and mats of the same material. There is abundance of cane and bamboo in places, and the missions are developing a beautiful cane-work, which should soon suffice to meet all local demands for chairs, sofas, small tables, etc.

I doubt if the wild rubber still in the forests will ever be sufficient to engage the attention of more than a few traders.

There are still plenty of elephants in this region, but the majority are small, so that the hunters do not make much money on the ivory. It is true that last year a white man killed two elephants in three days, near the Djombo pans, and each with tusks weighing about 160 lbs.; but, lest there should be too great expectations from that quarter, it should be recorded that another fine elephant-hunter had tried to get the same two elephants, without success, for three successive years.

There are fisheries along the Lualaba, taking fish from the great lakes. The dried fish is sent to the mines, chiefly for native consumption. The natives are expert fishermen, and during the war those of the Kisale villages alone prepared over 10 tons per month of dried fish from their lake.

There is a coffee plantation at Katompe (Katombe a Lupete), which a few years ago produced 3 tons per year of the most delicious coffee. The output will doubtless have increased since then. All over the northern part of this region the natives are being encouraged to cultivate cotton extensively. Palm oil and kernels are largely exported, and also there

are two soap factories on the Lualaba, but these use sesame, pea-nut, and wild-olive (mpafu) oil, as well as palm-oil.

For some years a blight has attacked the cassava, so that much less is being produced than formerly, but there is a corresponding increase in the cultivation of maize, and the Government is doing much to help in this by the introduction of good seed maize. (" Dent du cheval " and " Hickory King " seem to be favoured varieties.) In the inland villages where the soil is poor, the natives cannot produce good maize till they have burnt off sections of the forest, to enrich the soil with ash. Moreover, I am under the impression that the cultivation of maize in the cassava fields has done much to impoverish the latter and make it more susceptible to the blight. On the plains, however, there is an annual inundation, which gives the soil an ideal dressing for each crop, so that magnificent maize harvests are produced. The villagers of Pungwe and Kabanza have sold as much as 400 tons per year.

With European methods of ploughing and sowing, these plains should produce enormous quantities of maize, though a premature flood-time occasionally results in the natives losing the whole of their crop just before it ripens.

The natives also cultivate tobacco, millet, bulrush-millet, red kaffir-corn, sesame, pea-nuts, ground-nuts, and several varieties of beans, tree-lentils, bananas, sweet potatoes, pumpkins, cucumbers, and spring onions. More recently they have successfully produced rice, onions, potatoes, and various tropical fruits. Frequent experiments have been made with wheat, but never with success, though it grows well near lakes Tanganyika and Moero.

The highlands about Kamina, Kabongo, Musengai, and Mwabi seem well suited to cattle, but nothing in the way of ranching on a considerable scale has been attempted. There have been a few cattle here and there, and a small herd is doing well at Kaballa. Large parts of the country are quite free of tsetse fly, and we notice that as the buffalo are killed off or chased away, so the tsetse fly (*morsitans*) disappears.

Game.—The game met in this region includes elephant, two kinds of buffalo, roan and sable antelope, eland, bongo, two kinds of hartebeest, water-buck, reed-buck, bush-buck in two varieties, duiker, white-backed duiker (very rare), very big herds of lechwe, puku, and sichitunga, wart-hog, red and grey wild pig, hippopotamus, lion, leopard, hyena, and jackal. The natives speak of a rare animal which they call " kisesa-ntambo," and which they declare to be distinct from either lion or leopard, though resembling both ; but I have never been able to secure a skin, and am not sure that it is a distinct species, as the lions are often clearly spotted.

There are enormous quantities of wildfowl, and the great clouds that rise as one approaches the sandbanks of the lakes and rivers in September are extraordinary. Other game birds include guinea-fowl, red-legged partridge, khoraan, and bustard.

Development.—In 1915 there were only five white men in the huge Kisale Territory. To-day this territory is divided into three, and in that small section alone which is still called Kisale Territory (though Kisale is not in the territory), there are now over ninety whites. In 1915 one had to walk ten days' journey from the rail-head at Tshilongo to Bukama, on the Congo River. To-day one can go from Elizabethville to Bukama in a day and a night in trains as comfortable and well appointed as those of Europe. Already a magnificent bridge spans the highest navigable spot on the Lualaba (Congo) at Bukama, and it is expected that before the end of 1927 the Bukama–Ilebo Railway will be complete. Kamina has its 200 whites, its stores and railway repair shop. Bukama is also linked with Mato and Kamina by a motor road which is shortly to be carried on to Kabongo. Another motor road joins Katompe to the Lualaba. Every week or ten days a comfortable passenger steamer runs between Kongolo, Kabalo, and Bukama, making convenient connection for the trains to Kindu, Albertville, Elizabethville respectively.

The Government has recently taken over the hydrographic department, and doubtless the long-needed barriers to keep the papyrus from choking Lake Kisale will now be efficiently and permanently erected. Already the Lualaba's shallows and sandbanks are marked by sign-boards and buoys, while dredgers are at work to keep open a channel for the steamboats at the lowest water.

In view of the great mineral and commercial developments of the Katanga, there has been big shortage of native labour. Thousands of natives are employed on the copper-mines and railways, and the birth-rate of the native out of his own surroundings has proved appallingly small, while even in his own villages it is by no means large. Thus there has been an increasing incentive to recruit large numbers of natives from the villages of Lubaland. Indeed, some parts have been almost depopulated. To-day, however, there is every facility for the native to take his wives to the mines, and splendid legislation has recently come into force, which limits the recruiting to a given small percentage of the population, thus ensuring to the native a continuance of pastoral and village life, even though it may to some extent limit European enterprise.

It is the duty of each chief to see that his people keep the roads of his chieftainship in good order, but big roads through unpopulated sections are hoed at public expense. The native inter-village roads are being constantly improved, and even in the rainy season it is possible to travel in some parts of the country, along good dry paths, with simple bridges across the streams, and grass shelters, for the erection of tents, in villages at intervals of 10 or 15 miles. This is not yet done, however, as thoroughly as it might be, and one still has to take the plunge into the long dew-laden grass, or scramble through streams and marshes up to the neck, even on important main paths. The chief difficulty lies in

the "No-man's-land" between one administratorial territory and the next, this often being cared for by neither.

The natives are every year becoming more subject to the state, and it is possible to travel unarmed through this whole region. The Baluba, as a whole, have always shown a friendly spirit to the white man, for at the time when the Belgians first occupied the country, it was being overrun by Batetela rebels, who killed and tortured ruthlessly, so that the white man is regarded as a deliverer rather than a conqueror. This means that the natives are usually submissive and peaceful. Moreover, where there are villages that refuse to submit to the Government, or to pay tax, the white officials show a very creditable toleration, finding that it is not only cheaper, but more lasting, to subjugate the natives gradually and amicably than by military demonstrations and force. Thus it is still possible to find parts of the country where scarcely an individual has paid his tax, and indeed one still comes across isolated villages where no other white man has ever set foot, though this is practically confined to the region of the Luvidyo watershed.

It would not be fair to criticize too minutely the administration of justice in so young a colony. Every year sees great advance in the enforcement of the law by the white judges and administrators with magisterial powers; but also the local chiefs hold their courts for the trial of minor offences, and these are conducted in a manner often strange to European eyes. It is natural that the white officials regard the chiefs as the most competent persons to deal with petty affairs, but at present the consultation of necromancers and the administration of poison trial are quite a common feature of trials before the native chiefs. Every few months, however, the local administrators hold a "chauri"—a gathering of the local chiefs for administration and instructions in their duties. We trust that before long trial by red-hot iron, boiling water, and mwavi poison will be things of the past.

The educational and evangelistic advance has been phenomenal. In 1914 there was scarcely a native who could read or write, but there are now fifteen Protestant and four Catholic mission stations in this area, as well as some 200 village schools, while thousands of natives can read and write, and many are embracing Christianity. Almost every chief has his secretary, and numbers of the natives are becoming capable carpenters, bricklayers, cane-workers, etc. The Protestant missions teach entirely in the local native language, but the Catholic missions use more Kiswahili, while it is probable that all missions will soon have to introduce French into the curriculum, as this is the official language.

In past years there has been a terrible death-rate through sleeping-sickness and smallpox, as well as to some lesser extent through yaws, leprosy, and syphilis, but the Government medical service is now not only placing doctors and hospitals at conveniently reached centres, but is also assisting these by white "agents sanitaires" with trained native

helpers. Thus, by medical treatment of those already suffering, by isolation of the infected, and by constant hoeing of the river-banks in the neighbourhood of the villages, to prevent the breeding of the *Glossina palpalis* (found on that section of the Lualaba which is between Bukama and Kisale, and also on the Lufira, Lovoi, Luvidyo and Lomami rivers), much is done to combat disease. The native chiefs are coming more and more into line with these measures, rendering valuable service by reporting outbreaks of disease, and otherwise intelligently co-operating with the Government medical service.

There are also white experts for the study and development of forestry, agriculture, etc. I cannot help feeling that these whites in Government employ might render better service if they were to learn the language of, and confine their attention to, a single tribe—as *e.g.* the Baluba or Basongi—instead of limiting their intercourse with the natives to the Kiswahili language, which the natives, as a rule, only know fragmentarily.

Tribal Boundaries and Speech.—The boundary of the Baluba, on the north, is the Lubangule river to its entrance into the Lomami, from there along the Lomami to Kisengwa, and a line from Kisengwa through Katompe. At Kabongo-Engo they speak Kisongi, and at Katompe and Kisengwa both Kiluba and Kisongi are spoken. The Bene Milembwe and Bekalebwe speak a dialect of Kisongi.

The line of demarcation between the Kiluba and Kisongi is so clear-cut that natives from opposite sides of the Lomami river scarcely understand each other, though as Bwana Tshofwe was once a refugee on the eastern side of the Lomami, his people know more Kiluba than the other Basongi.

So far as I can discover, " Beilande " is a term used of those wandering traders, either Baluba or Bekalebwe, from the Ipeba, Kipushya region, who so often visit the Kisale and Kibara Territories, trading grass cloth for salt, zebra skins, etc.

According to the usual Bantu rule, a man Muluba belongs to the tribe Baluba, in the country Buluba, with Kiluba language and customs.

The natives are most exact in their names. Every hillock, every group of huts, every little stream has its name. Even some of the larger individual trees, rocks, and anthills are named. Thus in describing, *e.g.*, the place where an antelope has just been killed, perhaps miles away in the forest, one hears each thicket and patch of trees referred to by name, as accurately as we would speak of Piccadilly Circus or Holborn Viaduct. Our Mwanza Mission is on Kayembe hill, regarded as part of Kazembe, which is a portion of Kanguba village. Kanguba belongs to a group of hamlets called Sope, in the chieftainship of Mwanza. The Mwanza, Bunda, Ngoimani, and Ilunga Mwila chieftainships, with a few smaller ones, are included in that part of the country called by the natives Budya. Obviously all this is impossible to record on a small-scale map, even without regarding the Belgian names, which would add to our

list, Territoire de Kisale, District de Tanganyika-Moero, Province de Katanga.

Villages are either known by their own name, or by that of the headman or chief. Thus, though Pianimbayo is the name of the chieftainship, it is more often called Ntaha, because Ntaha is the chief. We have so far as possible recorded the name of the village or region, but this is not always easy. For instance, the northern part of the Bavumbu is presided over by Tukutuku, and it is only by his name that we have heard that part of the country is distinguished from the Bavumbu as a whole.

In a very large number of cases the first Europeans did not write down the native name accurately, and the distorted name has become so established through maps, etc., that we have recorded the now popular rather than the old original name. Thus Kisengwa is really Kisenga, Kikondja should be Kinkondja, Ankoro should be Hanga Nkolwa, Katompe should be Katombe a Lupete, and so on.

Origin of the Baluba.—About the time of Cromwell's commonwealth, the country now occupied by the Baluba was peopled by separate small scattered communities named Bakalanga. We are strongly inclined to believe that the relics of huge villages along the Lualaba represent a community that did not penetrate far into the interior of the country, for their remains in the way of pottery, copper ornaments, beads, and the well-known "Maltese cross" money seem confined to the rivers and lakes. They are those of a highly intelligent people, making beautiful pottery, using lamps (probably burning oil from the bikele fish, as the oil palm had not been introduced). They drew copper wire, and in other ways showed a considerable degree of development. Native historians say that these remains are those of the Bamumbawewe, or "mutterers," and that they were very big people, but the skeletons that I have examined, and the skulls in my possession, are not larger than the average.

There are also heaps of dross and other remains of the Ba-Kahasa-ka-Nsengo, most industrious iron-workers, who have left their traces right across Lubaland, but whether they were part of the Bakalanga, or whether they preceded them, as some natives declare, it is hard to say.

Authentic history starts with Kongolo, whose father Kimungu Banze Mpuya and mother Buya were Bakalanga commoners, about the middle of the seventeenth century. Kongolo gradually obtained a power over the people about him by a cruelty which was so merciless that he even buried his own mother alive because she laughed at him. Afraid lest he should lose this power by a disloyal wife, he married his own sister, Mumbwa Kasoya. Two other sisters, Mabelai and Bulanda, also lived with him. For this reason, to this very generation the installation ceremony of the Kasonga Niembo and Kabongo lines has included the taking to wife of their own sisters.

About this time the Muluba, Mbidikiluwe, heir-apparent to the

chieftainship of Membe, on Tanganyika, travelled westward with two assistants, and arriving at Kisale he married a lake-side girl, Kapandabanse Mwalaba, who bore him a son, Bumbwembidi, the first of the present line of Kikondja chiefs. From Kisale Mbidikiluwe visited Kongolo's budding kingdom, on the Lomami, and took Mabelai and Bulanda to wife. The latter bore him a son, Kalala Ilunga. Mbidikiluwe returned to his kingdom at Membe (which I believe is now Kasa on the river Moba to the south of Baudouinville), and he never saw Lubaland again. When Kalala Ilunga grew to manhood his uncle Kongolo planned to kill him, from motives of jealousy. Kalala Ilunga escaped and fled to his father, where he raised a great army. With this he returned and killed Kongolo, becoming first of the line of present Kabongo and Kasongo Niembo chiefs.

It was customary for each new chief, on his accession to power, to kill his brothers, lest they should become rival claimants to the throne, and when white men first came to the country, Kabongo and Kasongo Niembo were each attempting to kill the other. Had one succeeded, that part of the country would have had but one head, instead of the two as at present, though in any case Kikondja would still have been regarded as the " tutu " or elder brother of the other king, as he is descended from Bumbwembidi, the firstborn of Mbidikiluwe.

At the time of Kalala Ilunga's return to depose Kongolo there seems to have been a great migration of Baluba, from Membe, to occupy the more or less vacant lands which are the subject of the Luban part of our map. How far the original occupants were scattered or absorbed, and how far their language has died or survived in the present Kiluba, it is hard to say.

A word should be said as to the Baluba connection with Mushidi and Mwata Yamvo. Some native historians say that Mbidikiluwe's father wished his sister Mwanana to take the kingdom, but that at the father's death his subjects preferred Mbidikiluwe to his sister. However that may be, the sister journeyed south-west, and eventually arrived at the court of, and became a wife of, one of the Mwata Yamvo chiefs, so that the Baluba regard Mwata Yamvo with the usual warmth and respect accorded to relatives by marriage.

Some forty years ago Mushidi's armies covered and occupied a large part of eastern Lubaland. He was not haphazard in his occupation, but had a well-organized system. In each chieftainship he placed a representative, supported by a few soldiers. He placed garrisons at central spots, and put whole districts in charge of responsible generals, somewhat after the style of the present Commissaires de District. These were responsible to Mushidi for the collection of tribute, and the sending of prisoners, to be sold as slaves at Bunkeya, Mushidi's capital. Shimbi, who lives some 5 miles from Ankoro, was once Mushidi's chief of staff for all that region.

Cicatrization of the Budia region

Women from the south of Kasongo-Niembo

Stool of initiation of the Bambudye society

Members of the Bambudye society

When the Belgians took over the Katanga, they recognized, and as far as possible left in power, the reigning chiefs. This has led to some misunderstanding in the cases where the original chief was not retained. But the Belgians very rightly ask, " Since the Baluba of two and a half centuries ago forced their headmen on the place, and then in succession the Basanga of Mushidi, the Arabs, and the revolted troops of Batetela each deposed the former headman and installed one of their own choice, which of those various lines of headmen must we recognize ? " Rather than entangle themselves in further disputes, they followed the precedent already set, and placed their own chosen native as chief at Mulongo, Kisula, and Ipeba, for example ; while in other cases some powerful and intelligent man has been put in, to more or less take the reins of government, although the former chief remains in nominal power, as at Kabondo Dianda.

The Baluba do not as a rule live in big villages. Of all the villages on the map there are only six approximating 3000 each in population, and five of these are among the Basongi. From figures most of which were kindly supplied by officials, and based to some extent on the tax returns, we judge that there are 310,000 natives in the area shown by the map. The most scattered populations are in parts of the Kasongo Niembo and Kisengwa Territories, while the densest parts are from Kaballa to Kikondja, and among the Bene Milembwe.

The Baluba may be divided into two very different sections : the fishers and the agriculturalists. Of course, the agriculturalists sometimes set their basket traps in the smaller streams, and the fishers to some extent cultivate maize and kassava, though the former is not so much for their own means of life as for trade. They live chiefly on fish, and the water-plants " male," " mpu," " musamfu."

The fishers are weak in the legs, as a rule, but with an abnormal development of chest, shoulders, and arms, through constant paddling. They are bigger men than the agriculturalists, and their villages are often closely packed, right against the river or lake-side, or even on artificial islands in the marshes. They also erect temporary fishing-huts, and as the Lualaba rises, the water is kept out by piling more and more clay in walls around the huts, so that the fisher can paddle his canoe to the wall, climb over, and creep into his shelter below water-level. We have seen extreme cases during the exceptionally high water of February 1918, when these mud walls were so high that the fishermen actually slept securely from 6 to 8 feet below water-level.

The canoes are very poorly shaped, without any of the grace and symmetry seen in those farther down the Congo. Often they are not more than 16 or 18 inches wide, and when occupied show only an inch or two of freeboard above the water, which oozes through cracks that have been poorly stopped with grass and clay.

The fish are caught by nets, weirs, fish-dams and basket-traps, hooks

Members of the Royal Anthropological Society
Stool of initiation of the Bambudye society

and lines, fish spears, or poison. Also the women catch fish either by putting long baskets among the reeds, and chasing the small fry into them, or by surrounding sections of the shallow water with a mud barrier, ladling the water out, and then feeling in the mud for mud-fish and crabs, that are unable to get out of the barrier.

The agriculturalists are as a rule more slim in physique. They live in more scattered communities, and one can sometimes pass fairly big villages without seeing more than one or two huts, as most of the people live near their gardens during the rains, and as soon as the grass is ready to burn, they go out into the hunting camps for the dry season. They are nearly always in close proximity to streams, though by the end of the dry season one often finds all the people of a big village drawing water from one dirty little pool.

Wherever there is forest the natives like to build near it, only hoeing in front of their huts, in order that a few strides to the back may bring them into safe hiding. Often big barriers of logs and branches are built either round the gardens, or for as much as 2 or 3 miles through the forests, with gaps at intervals. Game-pits, wide at the top and tapering to nothing some 10 feet down, are dug in these gaps. They are covered lightly with twigs and grass, and sometimes catch abundance of wild animals, thus affording both protection and food to the village. Both fishers and agriculturalists keep sheep, goats, and pigs, but not largely. They also have fowls, pigeons, muskovy ducks, and dogs.

Native Organization.—Each chief is supported by counsellors who may be up to twenty-five in number. These all have distinct titles and duties, order of priority being rigidly observed. There was a time when no one was admitted to this aristocracy before he had killed a man, in sign of which he wore a bright carmine " Nduba " feather in his hair, but to-day any man who, whether by gifts or worthiness, secures the approbation of the chief, may become a " mfumu," or counsellor. The chief and his counsellors are very dependent on each other, and neither will, as a rule, take any step of importance without talking it over with the other. There are two agencies sometimes more powerful than either the chief or his counsellors: the necromancers and the secret societies.

Necromancers are distinct from ordinary medicine-men, though one man may practise both professions. The medicine-man is simply a compounder of charms, fetishes, and remedies, or perhaps a specialist in poison-trial, while the necromancer is supposed to be possessed by the spirits of the dead, and holds tremendous power. The natives will consult him about sickness, loss, or misfortune, and seek his advice before hunting, going a journey, selecting a garden site, etc. Much native custom originates in the necromancer. It is he who decides that the chief must not be seen eating or drinking in public, that the woman must never eat with her husband, that the Southern Luban must knock out the two lower, and the Northern Luban the two upper, front teeth.

All the necromancers in the chieftainship are under the direction of a superior, the " mwizeme," who generally receives an initial fee, and directs the client to one or other of his subordinates for the actual consultation. This " mwizeme " pays a proportion of all gains to the chief, and on account of this handsome gain the latter naturally " thinks twice " before taking any action that is contrary to the former.

There are three secret societies : the Bantambo, the Bambudye, and the Bakasandji. Also members of the Batonge and Batwa societies, from farther east, pay very occasional visits.

The Bantambo exist only for the sake of extortion and revenge. They pretend to be lions, and tear their victims at night with an iron instrument. It is said that they put wooden imitations of lion's pads on their feet. Fortunately they are very rare. I have only known two or three well-established cases in the neighbourhood of Kisanga, but they are so secret in their working that I have not been able to get the instruments with which they kill their victims, and cannot be sure whether they are of the same order as the " human leopards " of whom one hears reports on the West Coast.

The Bambudye are extremely powerful. In some parts of the country between Ngole and Pianimbayo almost every one is a member, and non-members or " ngulungu " who visit those villages find it very hard to obtain food or shelter. The society is strong from end to end of Lubaland, and its secret language is the same throughout the country. In public the Bambudye are dancers, and because of their otherwise drab and monotonous life, the natives crowd to the Bambudye and " Butanda " (initiation into womanhood) dances in great numbers. In secret, however, the Bambudye exist for mutual help and protection, for beer-drinking, for extortion, and above all for immorality. The head officer " Kikungulu " of every Bambudye community pays the local chief a big sum of money yearly, in token of professed subjection, but actually we have known the Bambudye to kidnap chiefs who were suspected of unfriendliness to the society, tying them to trees in the forest at night, and refusing to liberate them till they became members.

The Bakasandji are far more sinister. They are found occasionally in most parts of Lubaland, but are strongest on the east side of Lake Bupemba. No one is allowed to be initiated among them until he has eaten part, generally a bone, of some other human being, on the principle " I am now a super-man, for I am myself and the other man as well." One may often see fires out on the Kisale plains at night, where the Bakasandji are digging up corpses, in order to chew the bones. The Bakasandji also dance, but their chief *raison-d'être* is the compounding of magic, supposedly very powerful in giving blessing, long life, etc.

The Religion of the Natives.—The natives thoroughly recognize one God, the Creator and Sustainer of all things, but they give Him very little thought. With them death liberates the spirit from the body, though

it may linger for a long time in the neighbourhood of the body, and is provided with beer, etc. A subconscious self, distinct from the spirit, is also recognized. The disembodied spirit is the object of the greatest fear and respect. Natives provide spirit huts for their dead relatives, and see that these are regularly provided with food in the morning, and with warm embers at night.

There are big idols of various kinds, portable and stationary, but the native has no respect for the idol itself. The wizard places a horn or other charm on the idol, and it is then thought that a spirit is induced to enter it. It is this spirit which is the real object of worship. We have known natives to punish their idols by whipping or other indignity, when these idols have been asked to do something and have failed to do it.

All sorts of misfortune are said to be brought about by the spirits of the dead. They cause the snake to strike, the leopard to carry off the goat, or the root in the path to trip up the passer-by. Pneumonia is a spirit squeezing the chest, and indigestion is a spirit in the form of a snake gnawing the entrails. Often the natives have raised objection to our killing a snake or wild animal that has caused loss or death, for fear that we should incur the anger of the spirit who possessed it.

Any large or abnormal tree or rock, any waterfall or other striking natural object is supposed to be the dwelling of a spirit. Spirits are said to take possession of some men, while other men, by their magic, can make the spirits serve them. Some are believed to possess magic which enables their spirits to leave their bodies at will, so that they can become invisible for purposes of theft, revenge, or escape. All these spirits are to be propitiated through the mediatorship of the necromancer.

In addition to these departed spirits the natives fear various kinds of gnomes, fairies, giants, etc., though what is a very real terror to one man is regarded by others no more seriously than we regard " Mother Goose " or " Father Christmas," the tradition being merely kept up for custom's sake.

Native Signalling.—The signal drum takes a prominent part in native life. Its function is more that of an actual language than of a code. Kiluba, like other Bantu languages, has tones as well as sounds, and the drum follows these. Drum-signals are a very uncertain way of sending messages, being dependent on the direction of the wind ; but once, when the thing was properly staged beforehand, we received a message from Tshilongo to Mwanza, about 300 miles, much of which was poorly inhabited country, between 7.30 a.m. and 4.30 p.m. There is also a method of signalling by the reflection of fire on a column of smoke at night, but the natives say that it is only known by very few, and is a jealously guarded secret. We have only once seen it.

Standard of Intelligence among the Baluba.—The term " Baluba " is foolishly used by white men in Elizabethville as an insult to the native, so that to-day many natives on the mines are ashamed of their nationality.

One hears the expression "as foolish as a Baluba," which is neither grammatical nor just, for though their bodies are often dirty and their villages squalid, they are thoroughly intelligent. They have hundreds of proverbs, fables, histories, and other oral literature, deep in philosophy. They have a well-recognized musical system, with each note named, and if one call for any one of a hundred tunes, the really good native musician will play it accurately. Their scale covers a septave instead of an octave.

In an intricate case of native law, where the witnesses on both sides are lying shamelessly, and bribes are passing freely, one who hears the chief wriggle and question his way to the truth, must admit that the Luban is no fool. There are Luban hospital assistants who do intra-venous and intra-muscular injections, and are keen at microscopic diagnosis of dysentery, malaria, and sleeping-sickness. Some of the passenger trains of the Katanga are driven by Lubans, while others of the Baluba are intelligent clerks in the employ of European traders.

Cannibalism is sometimes quoted as an evidence of the low standard of Baluba intellect, but excepting for the Bakasandji, of whom we have spoken, or for the occasional outbreak of some single individual, cannibalism is practically confined to the neighbourhood of the Luvidyo watershed. There it certainly still exists despite serious Government efforts to prevent it. Apparently "bwilu," the craving for meat, is as strong among those natives as the desire for alcohol among certain Europeans, and when they cannot get other meat they kill and eat human beings; but they are fairly intelligent, nevertheless. One finds among these cannibals creditable iron-workers living in well-kept villages, and capable of intelligent conversation which is as full of proverbs and lore as that of any other Baluba.

The Basongi, including the Bekalebwe and Bene-Milembwe.—We cannot speak as fully of the Basongi as of the Baluba, having lived eleven years with the latter, and only occasionally visited the former. The Basongi are independent and fearless. With the Baluba safety lies in flight; but the Basongi villages are well laid out in streets, and generally on the summit of a hill where safety is rather in combination and defence than in running away. Their huts are so large and clean that an European might occupy them. This is very different from the Baluba, whose squalid huts are often verminous. Indeed, from Kabenga southward, and from the Lovoi and Kiankodi westward, the Luban huts are infested with the intermittent fever tick, but the Basongi keep their huts neat, well smeared, and free from vermin. They are also more skilful in ironwork, weaving, and canework, while their well-arranged gardens are in strong contrast to the untidy patches of Luban garden cultivation. From personal experience, and from the testimony of fellow-workers, we should judge that the Basongi are much more superstitious and cruel than the Baluba, and they do not have the same wealth of tradition. The Bekalebwe travel even as far as the Kibara plateau, trading charms,

arrow poison, and grass cloth for salt and zebra skins, and everywhere by daring and cunning they enforce respect.

The Map.—The main mountain points have been located by triangulation with a prismatic compass, starting with a measured base. Villages between have often only been measured by time occupied in walking, though occasionally a cyclometer was used. Villages not far from the course of the journey were not always visited, but were located from the directions of the local natives, or of our native evangelists, with the help of the compass. Altitudes are only very approximate, having been taken with an aneroid barometer.

As the huts decay, or are vacated on account of death, impoverishment of the garden land, or the using up of all available firewood, so the villages slowly move, though only within the boundaries allotted to them by the chiefs. This means that the places marked for the villages on the map are only approximately correct, though they are not likely to move more than a mile or so in any direction from the locality that they occupied when mapped.

The map was originally made to enable me to plan for the evangelization of every village, so that I have recorded all the villages so far as I know them, but doubtless some have been overlooked, and specially in the Bitumba and Kabinda neighbourhoods, where I have recorded only a few villages, from long-distance compass measurements, and from the note-books of my fellow-missionaries.

No observations for latitude and longitude were made. My traverses are simply fitted in as well as possible to the existing framework of the Belgian map.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: We are about to listen to a paper upon a region about which we have heard, so far as this Society goes, singularly little for a long time—the Belgian Congo. And when we did hear about it before the war, accounts of it were distinctly critical. It is a great advantage to us to-night to be able to hear at first hand an account of the country as it is at this moment, and I think you will realize that a very considerable change has come over the spirit of the Belgian dream. Our speaker is one of a class which has given to the world many explorers and some of the greatest: that is to say, he is a missionary, one of those people who on a great scale, like the archæologist and the naturalist on a smaller scale, have the advantage of coming into the closest touch with the ordinary people. He does not see merely officials or the people along the banks of the rivers; but he sees the people in their own inland villages. I expect to-night an intimate account of the people of this region, in a way so well known along the lines of the railways and the rivers, but so entirely unknown a few miles back from those great arteries of communication. I will ask Mr. Burton to give you his account.

Mr. Burton then read the paper printed above, and a discussion followed.

The PRESIDENT: We have the advantage of having with us the famous anthropologist, Professor Henry Balfour, who is Keeper of the Pitt-Rivers

Museum in Oxford. Has he any comments to make on the savage rites of which we have heard so much?

Professor HENRY BALFOUR: Since you have called upon me I can but obey, but I must say that I feel very diffident about speaking, especially after we have listened to such an extremely interesting and informative and, I might also add, dramatic lecture, the effect of which I have no desire to spoil. It is quite obvious that we were all enjoying ourselves thoroughly and absorbing a very great deal of information. Personally, I came here to learn and not to impart, and I thank the lecturer for his instructive discourse.

Mr. Burton has touched upon so many varied points of interest that it is really difficult to select any special ones upon which to hang the few remarks which I will offer. There is one which has always struck me as being of extreme interest, and that is the iron-working industry as practised in what some people speak of as Savage Africa, that is to say, Africa south of the Sahara. It presents all sorts of interesting problems to the ethnologist and the archæologist, and one thing that is remarkable about it is that the African negro passed directly into an Iron Age from a Stone Age, "short-circuiting" the process which has been more usual in other parts of the world; in other words, he has skipped the Bronze Age. So that the evolutionary series is quite different in this area from what it is in those other regions where an Iron Age was arrived at by a gradual process. And perhaps what I call for brevity the "short-circuiting" of the Bronze Age is particularly remarkable in connection with the district about which we have been hearing, inasmuch as in the Katanga district copper is abundant and has been worked for a considerable time, and tin, the other ingredient of bronze, appears also to be abundant. So that, in spite of the fact of these materials being available and fairly ready of access, this normal episode in the evolution from the Stone Age to the Iron Age has been omitted in this area. There are other points that are extremely interesting in connection with the Iron Age in Africa. One is that it is evidently of very great antiquity; how ancient it may be we have at present no means of determining, but if we can judge from the skill which is exhibited by some of the native smiths—I believe the Baluba smiths are a case in point—we must assume that a very prolonged period must be postulated during which they gradually gained their experience in the working of a somewhat difficult material, and we must give them sufficient time to have reached a pitch of excellence in their craftsmanship which can perhaps best be illustrated by the fact that you can take some of the pieces of ironwork which have been forged by native African smiths, offer them to our own blacksmiths and ask them to copy them, and they will fail to do so. The native skill is to some extent greater than the latter have at command. That speaks very highly, of course, for the smith's work in Africa; and also, I think, it indicates that this industry is probably of very great antiquity. In fact, there are those who have urged that it is possible that this industry of iron working may have been initiated in Savage Africa and from thence disseminated over the areas of higher civilization. That is rather a bold theory, of course, and not one which one would accept at all readily; but at the same time it is perfectly possible, as Dr. von Luschan did many years ago, to make out a plausible case in favour of this theory, and at least it is interesting to debate the possibility, at any rate from an academic standpoint. It raises all sorts of interesting points, and forms an intriguing and fruitful subject.

There were many other points to which Mr. Burton referred. The drum-signalling, for example, which is very widespread indeed, because practically

the same method of conveying signals to a distance, especially from hilltop to hilltop, is practised in parts of the world so diverse as the Cameroons, Gold Coast, Congo, in Africa; and in the East right away as far as Melanesia. I have seen it in use on a very big scale in the Naga Hills of Assam, where—I do not like to call them drums, they are really hollow wooden gongs—the gongs are developed to such an extent that some run to 40 feet in length and 5 feet in diameter. They are cut from enormous trees, carried up by manual force to the hilltop villages and erected there for the purpose of conveying messages rapidly over a wide extent of country. And the same thing applies to the New World. There you will find, certainly on the Upper Amazon amongst such people as the Jivaro, that exactly the same type of instrument is used for the purpose of conveying messages by a system of beats. And for that matter the ancient Mexicans had an instrument almost identical with one shown upon the screen, which also served the same purpose. So that we are dealing with a practice which, although it is not world-wide, at any rate has an immense distribution, and it is very interesting because there are different methods whereby the messages can be conveyed, and these methods differ in the different regions in which the practice obtains. In some instances the system would seem to be practically a kind of " Morse code " with the equivalent of long and short beats, usually effected by having the instrument either tuned to two notes, or by using two instruments each having a different note. In that way the two notes can be sounded variously, and, by the combination of sounds on a kind of Morse system, messages can be conveyed where there is common consent as to what those systems of beats actually signify. Then, on the other hand, instead of that kind of " Morse " signalling, there is the form of signalling which, I gather, is that practised by the Baluba musicians, where the method is a mimetic one and there is a definite attempt to imitate sounds and syllables of native speech. This, of course, is a different method; it evolves a different kind of beat and also it practically necessitates that the language which is being imitated must be one of the *tone* languages, such as Kiluba and such as you meet with in Ashanti and in most other parts of the Bantu area.

Before I leave this platform I would like to say one thing in regard to the development of this area. I gather from Mr. Burton's account that development is going on at an extremely rapid rate. Railways are beginning to encroach; motor-bicycles have already encroached; motor-cars are following. Well, I think we know what this is going to involve. It means advancement, no doubt, but it also means something which worries the ethnologist very considerably indeed, because it implies that the culture of the people will undergo a very very rapid metamorphosis. One's hope is—I am speaking as an ethnologist, of course—that before those changes have become too drastic, a detailed study of the natives, their habits, ideas, and point of view may be made while there is time. In a very short time it will be impossible to get the information which is desired, and when it is too late we always feel that desire more than ever. I should think it will be too late very soon in this particular area which is being developed so rapidly. So I would urge that we should take every opportunity of encouraging people like Mr. Burton who are willing to reside in the country more or less continuously and who are also willing to take a keen and sympathetic interest in the natives—and that we should urge them to make a thoroughly intensive study and write it all down, so that the record of what will soon be " byegones " may be permanent.

The PRESIDENT: I am afraid there is no next speaker. All Mr. Burton's colleagues and companions are hard at work in the Congo, so that none is here

The wife of the spirit of the boiling spring at Kulu

Woman from near Sungu Monga

A "mukasandji" from Ngoi Lundu

Relics of a race that preceded the Baluba

Clay lions guarding a village in Mato

to give us further details about the country. Before I ask Mr. Burton to reply I would like to ask him what is the form of the wooden head-rests which the women use at night for sleeping. I ask because there are curious Egyptian resemblances about both the whole culture and, to some extent, the facial type which has survived there. We know the ordinary Egyptian head-rest or pillow—an upturned half-circle supported by a pillar on a base; but that is not the only form. In the earlier Egyptian times there was a simpler one: a block of wood with a piece hollowed out for the back of the neck to rest in. The purpose of all forms was to support a head which had been elaborately dressed and which the owner could not afford the time every day to redress; therefore she wished to keep her elaborate coiffure in its original arrangement through the night. But I should like to know what the form of this Katanga head-rest is.

My other point involves the secret societies. There is a great deal one might ask and say about them. But would Mr. Burton only tell us whether anything is known about their origin, or the length of time they have been in existence, and whether they represent in any way the survival of an earlier religion than is practised by the people at the present time? That is often the explanation of a secret society. Or, on the other hand, have these been formed for the particular purpose of protection, as, for example, protection against the white man since he came into the country? This would be, of course, to presume that some may be very modern. It is always possible that they were formed expressly for the practice of immoral rites, but one cannot help remembering that every secret society in the world has been accused of gross immorality by those who did not belong to the society and did not approve of it. Was not exactly the same accusation made against the early Christians by the Romans? If Mr. Burton can tell us anything more about the origin of these Katanga societies I for one shall be grateful. Therefore I ask him if he has anything to add in reply to Professor Henry Balfour and, what is less important, in reply to me.

Mr. W. F. P. BURTON: I would like to remark on the omission of the Bronze Age in Lubaland. Although there is plenty of tin ore on the spot, the natives did not realize that there was metal in it until they saw the white man extract it. They knew the value of iron ore and made their iron instruments from it, but they did not know that tin might have been combined with their native copper to make bronze. Also, though we have dug up copper ornaments, there were no copper weapons.

The native pillow is a simplified stethoscope on the heart of Mother Earth, that the native in his hut, with his head upon it, may be aware of all that is going on outside. Sometimes it has a smooth flat top; sometimes a curved top to fit the head; but it has a small stem, widening out to a trumpet-shaped base, by which device an old man lying in his hut may hear the patter of feet not only of larger animals such as jackal and civet-cat, but even of rats or lizards running past outside.

We have made many inquiries as to the origin of the secret societies. All that we have discovered is that the Bambudye came some few generations ago from the north, where they had been established for much longer, Hanga Nkolwa having been an early centre of their society. It was only in the last generation that they really became a force in the Mwanza region.

Seeing that the presiding spirit of the sect, Lolo-Inangombe, is supposed to be half woman and half buffalo, and that there are also traces of phallic-worship, one is inclined to think of the Bambudye as coming from the old

Eleusinian Mysteries, centaur, and things of that kind; but we have not been able to find anything really definite as to their origin.

I might say that I was asked by the Government to report on the Bambudye society, and was able to satisfy our friends of the Administration as to the immoral practices, chants, etc. It is all too evident that they are foul. Our native is a strict exogamist, never marrying in his own village, but in the "kinyergele" of the Bambudye he gives way to the wildest promiscuity.

The PRESIDENT: We are very much obliged to Mr. Burton for the lecture which he has given and for his illustrations and, if I may so call them, the frills so unusual in lectures. In fact, I do not think that we have had so gifted a lecturer before us for a considerable time. But, quite seriously, what he has told us has shown not only that he has remarkable powers of representing the native, but also that he treats him with sympathy and puts an amount of diligence into studying him and his customs and practices—for instance, his drum-signalling—which are rare. Well, you have already, by your reaction to his lecture, amply assured him of the interest which you have felt in what he has said and the appreciation with which you have followed it.

THE STEREOGRAPHIC SURVEY OF THE SHAKSGAM

Major Kenneth Mason, M.C., R.E., Survey of India

Read at the Afternoon Meeting of the Society, 9 May 1927. Map following p. 416.

AT the afternoon meeting of the Society, on 13 April 1922, Mr. Hinks remarked that he had not come across any example of a stereographic survey on a scale smaller than 1 : 20,000, except that of a small area in the Cumberland Lake district by Lieut. F. V. Thompson, R.E., in 1907, on a scale of 1 : 63,360. This occasion was my introduction to stereographic survey, for I assisted Thompson both with the photography and with the subsequent plotting on his machine. Later, in India, I persuaded the Surveyor-General to obtain a Thompson Stereo-plotter, and in 1913 I took pairs of photographs during the course of geodetic triangulation on the Pamirs, and plotted them in the Thompson instrument on my return.

In both these small-scale surveys it was difficult to convince practical surveyors of the utility of the method. Stereoscopic accommodation is obtained by novices in varying degrees, and full accommodation—I include rapidity and ease—only comes with practice. Those with eyes of equal power will find stereoscopy easier than those with a powerful master eye, and those whose eye muscles have been developed by practice will find stereoscopy a pleasure. The practical surveyor, who has been brought up solely to use the planetable, and who cannot easily fuse a stereoscopic image, has always been sceptical. Those who believed in the method were dismissed as extravagant enthusiasts by the sceptics.

The result of this attitude has been that we, in England, have fallen behindhand in the development of photographic survey methods.

Though Thompson's instrument was admittedly very imperfect, its invention was a great step forward, and in the first British patent specification for the Von Orel Stereo-Autograph, Messrs. Zeiss referred to Thompson's paper in the *Geographical Journal*, and acknowledged their indebtedness to the inventor. Several automatic plotting machines are now on the market, all designed on the Continent. They have been evolved primarily for large-scale and technical surveys. In England, where the Air Survey Committee functions, reports have been collected on these Autographs and Cartographs, but their suitability for air survey, as against ground survey, has been the main consideration. Nevertheless, owing to modifications and great advances in design, the base conditions for stereoscopic survey, which were, owing to their limitations, the main cause of criticism in the earlier models, have become far less exacting. Both Mr. Hinks and I felt that the application of the method to reconnaissance and exploration work deserved consideration and experiment; and from my first mention of a wish to try stereoscopic survey in the Shaksgam, I enlisted the enthusiastic co-operation of the Secretary.

On 18 January last year, at an afternoon meeting of the Society, Major Hutchison and Mr. Hinks read papers describing the Wild Photo-theodolite. This was the instrument which the Council purchased after exhaustive inquiries to ascertain which of the various models on the market was most up to date. This photo-theodolite the Council kindly lent to me for the experiments, together with its accessories. Chemicals, developing outfit, Imperial Special Process plates, etc., were purchased for the Survey of India by the good offices of the Society, and the whole outfit reached me at Simla early in March last year.

This field equipment is designed for use with the Wild Autograph, which has been specially constructed to plot the photographic pairs rapidly and accurately. I am not going to attempt to describe this machine. I could not do so intelligibly without one to show you, however much I tried. I understand it myself, thanks to Mr. Hinks and Mr. Hunziker, and a very good and concise description of it will be published in the *Journal* by the former, together with this paper. I will here only say that though it is most complicated to describe and difficult to explain geometrically, it is comparatively simple to operate, extraordinarily compact, and magnificently designed and constructed. How all the moving parts fail to foul one another during the plotting is a never-ending source of amazement to me.

Before commencing to describe my Shaksgam work, I will answer at once the various questions raised at that afternoon meeting last year, in order to avoid mixing them up with details later. I will not describe again the photo-theodolite, for I cannot improve on the published account.

The first point is the accuracy of the theodolite. At Simla, before

starting, I tested my readings against those of a second observer. We often read the same second, and were never as much as four seconds apart. But the illuminating prisms should not be moved during a round of angles. At the close of the expedition, I took three or four rounds of angles to well-defined points and obtained practically identical readings, which never differed by more than 2·5 seconds. On the expedition itself, my observed points were often very ill defined, and I got larger differences, through no fault of the instrument.

I did not care for the specular illumination of the circles, and in reading the vertical angles, I always reflected light into the prisms with white paper. Mr. Wild is now adding white matt surfaces for reflecting the light. He is also considering the provision of a rack and pinion to insert the prism for reading the vertical circle. These improvements have already been incorporated in the larger model of theodolite.

Some doubt was expressed whether the complicated system of lenses and prisms would stand rough usage in the field. Either the instrument did not have sufficient rough usage to damage it, or it was capable of withstanding it. The sponge rubber cases supplied by the Society were excellent, and did not deteriorate, though I had to re-set them with rubber solution twice during the expedition.

The optical system was unaffected by dust or moisture. But it was not a severe test for the latter, for Ladakh is excessively dry and we had no fog or dew.

I found the collimating level a great boon. It kept in perfect adjustment and saved much time during the observations. The diagonal prisms for reading high elevations were also quite convenient, once one became used to reading the micrometer reversed.

The experimental electrical illumination for night work was not altogether satisfactory, being added at the last minute. Mr. Wild has already improved it.

In the dry climate of Ladakh, the wood of the tripod shrunk in the sockets, both near the head and at the feet. This was easily remedied by tightening up with the socket keys. We had some very high winds to contend with ; the tripod was rigid enough for observations, though for safety I had to dismantle the theodolite on more than one occasion. I found that if I used the theodolite in a high wind without the camera in its place, it was not quite steady.

Colonel Jack doubted the method of fixing the theodolite with two quick-motion screws to the tribrach stage. These screws worked quite satisfactorily in practice. I found the omission of sights a drawback ; but Mr. Wild has told us that he is now fixing them to his latest patterns. The milled heads are perhaps too much alike, but this is a minor point, and it did not offend me.

The only really serious drawback I found to the instrument was the limitation in elevation to 42°. This was inconvenient at times, for at

most of my photo-stations I wanted a sun azimuth to assist the computation for resection, and this meant that I must observe the sun before 9 a.m. or after 4 p.m. in those latitudes. I admit that the sun is best for azimuth before or after these hours, but at high altitudes beggars can't be choosers.

There are two points about the camera which I will mention: The objective is amazingly good. The plate-carriers were not light-tight. I had to use the utmost care not to touch the face of the carriers, and though I covered them with a velvet hood, kindly made for me by Mrs. Hinks, both on taking them from their box and during exposure, light filtered in sometimes. Mr. Wild has now designed a new pattern, which was recently tested satisfactorily in Switzerland by being exposed to sunshine for two hours. But for still greater safety, even this new design should be dulled.

I think I have answered all the points raised at last year's meeting. The photo-theodolite emerges from these tests very satisfactorily. The few criticisms are really very superficial matters compared with the beautiful design and workmanship, and with the many solid advantages which this type of instrument has over the old, both for accuracy and rapidity. For convenience of transport and rapidity of work at camera stations, I prefer to have the camera and theodolite both mounted on one tripod, and not separately, as has been suggested; and I can best sum up my own feelings on the subject by saying that I hope I shall never have to observe with an old-pattern theodolite again.

This is all rather a digression from the Shaksgam. But I must still explain that at no period did I intend to make a *complete* map by stereoscopy. I knew that the difficulties of transport and uncertainties of travel would prevent the possibility of a proper reconnaissance for camera stations, and as the whole method was experimental for this class of work, I preferred to rely for my general map on the planetable of Khan Sahib Afraz Gul Khan, which could be controlled by my triangulation with the photo-theodolite. Also I had no technical assistant, other than the Khan Sahib, in survey or photography, though Captain Cave learned to use the instrument during the expedition and was most helpful when available.

When we left for Kashmir I was personally convinced that the photo-theodolite was admirably suited to the experiments and that these had every chance of being successful, provided the previous triangulation on which I depended was sufficiently accurate for resection work. This triangulation was far from geodetic. It consisted almost entirely of reconnaissance and exploration points, generally snow peaks unmarked in any way, and often fixed from small bases by different observers. The test therefore was a severe one.

I will make three groups of our experiments. The first includes a number of photographs taken within the area of the planetable survey,

in order to form a comparison between the two methods. The second comprises a number of photographs taken from stations at the edges of our planetable survey, in order to test the value of the method for long-distance reconnaissance survey. And the third is a small series of photographs taken on the line of march through Nubra in Ladakh, without any control points identified for certain, to test the limitations of the method for the revision of old maps.

In these tests the bases were of various lengths up to about 900 metres, the smaller ones being measured with the subtense bar provided with the outfit, the larger ones being computed after resecting each end. In only one instance was the camera axis normal to the base, and on one occasion it was inclined as much as 50° to the normal. The camera was tilted downwards on two occasions, and at times the axes were convergent. The base was never horizontal, as much as 100 metres difference being measured between the two ends of one base. Both cameras were used, the focal lengths being 165 and 250 millimetres.

The views were taken across valleys, up and down valleys, in close and in open country, in order to find out what conditions were best. Camera stations, or one of them, were generally resected by the photo-theodolite, but in one or two cases I had to fall back on planetable re-sections. On these latter occasions the base was very carefully measured by the subtense bar.

I will mention a few points about the field work. Though the Wild Autograph will deal with, and actually did deal with, minor errors in the field, great care should be taken to level the theodolite carefully and to record correctly the various elements of inclination, tilt, and convergence. The Autograph finds out any errors and will correct them, but time is lost when setting, if this has to be done. In the field there was some difficulty in getting suitable camera stations and bases, but this was chiefly due, though perhaps not entirely, to the high altitude and my own lack of experience.

It is essential to use first-class plates and to take great care with the photography. The Imperial Special Process Plates left nothing to be desired, and were in every way excellent. But however perfect the plates, I am convinced, from previous experience, that where definition is essential, as it is in long-distance micro-stereophotography, the development of the plates must take place in the field. I am certain that after exposure to light even the best emulsions tend to deteriorate if development is delayed. I personally developed all my negatives in the field by the tank method as soon after exposure as possible.

I now come to the actual plotting of the results. The Government of India placed me on deputation to Switzerland for one month with Lieut.-Colonel Sackville Hamilton of the Survey of India. Mr. Hinks was deputed by the Council of the Royal Geographical Society to join us and study the working of the Autograph. Before leaving for Switzer-

land, Mr. Hinks and I collected all our data in what we considered the most suitable form, the former kindly converting my spherical co-ordinates to rectangular.

There are at present five Wild Autographs in commission in Switzerland, two being at Dr. Helbling's Topographical Institute at Flums. Dr. Helbling very kindly allowed us the use of one of these for one month, and placed the services of Mr. Guido Hunziker, his chief engineer, at our disposal for that period. I wish here to acknowledge our very deep gratitude to these two gentlemen for all their courtesy and assistance. To enable us to plot our photographs, and at the same time to fulfil his own contracts, Dr. Helbling had to put double shifts on to his other Autograph—a practice which is always inconvenient and expensive. We also took up a lot of the time of Dr. Helbling and Mr. Hunziker, both of whom helped us in every possible way to master the intricacies of the instrument. The plotting itself was done by Mr. Hunziker and myself, taking turns at the Autograph.

We plotted three maps, one for each type of experiment. The accuracy test is on the scale of 1 : 50,000 ; the long-distance test is on a scale of 1 : 250,000 ; and the Nubra experiment 1 : 125,000.

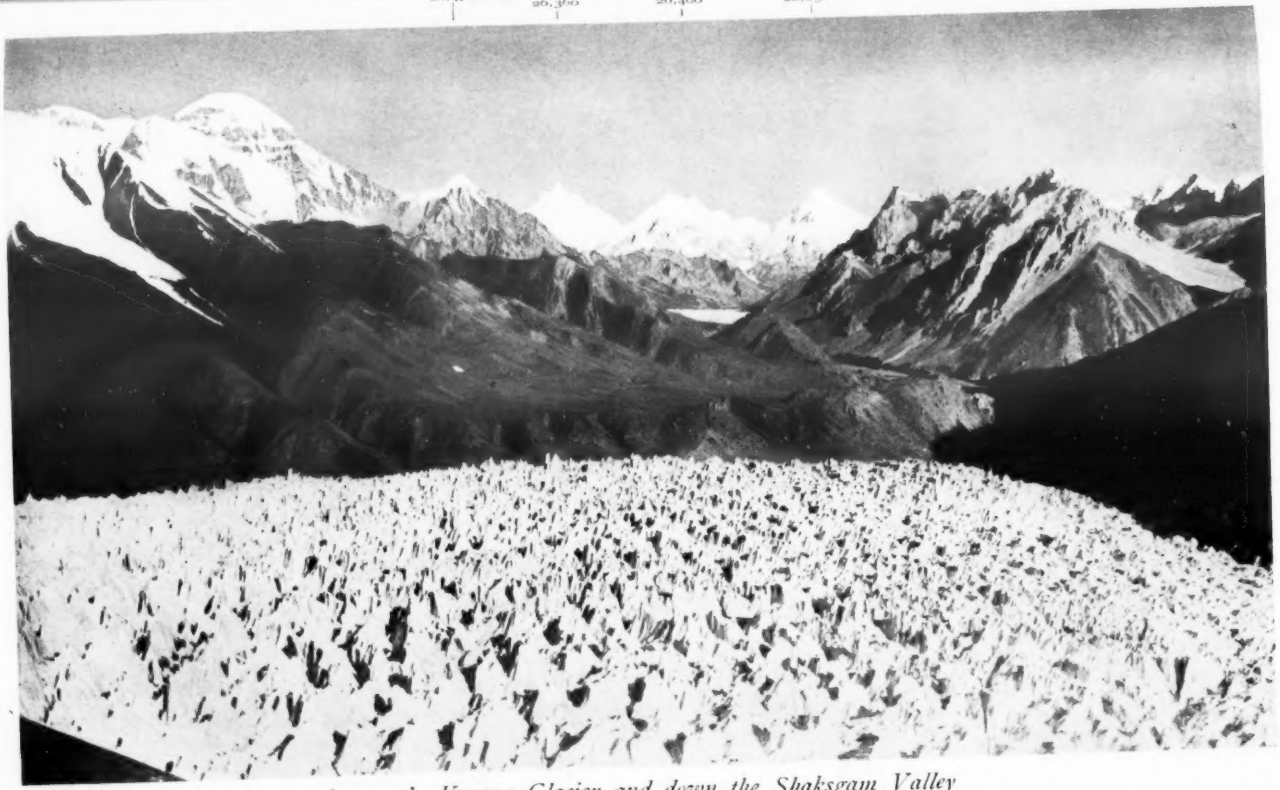
I will now take each map separately. We selected the Kyagar glacier and neighbourhood for the first test, partly because we had more control points, and partly because we could combine more pairs of photographs, and therefore could test the junctions of pairs better. Here we had four camera stations, W4, W5, W6, and W7, on the ridge east of the Kyagar glacier, and on the bases W5W4, W6W4, W6W5, W7W5, and W7W6 we had five pairs of photographs taken with the small camera. My stations were resected from the Survey of India positions for Teram Kangri I., the Gasherbrums, and K_2, and one of my own less accurate points. The centre pair was controlled primarily on Teram Kangri I., and the adjacent pairs were set on points of detail derived from the first pair and checked on the trigonometrical control. The rest of the detail of these other pairs agreed most satisfactorily. On the left, Grant Peterkin's peak No. 27 coincided almost exactly with the Autograph position, and the height was correct within 20 feet. Colonel Wood's two points, 16^1 and 16^2, fell on the Karakoram crest-line, though, as they were not peaks but only points on the ridge, it is not possible to say whether they are absolutely exact. Teram Kangri III. agreed perfectly in the next pair to the right, and accurate positions of the other salient peaks of the range in the neighbourhood of these peaks have been obtained. These positions may be considered as trigonometrically correct. On the extreme right of the series of photographs there was a difference of about 50 metres on the ground at a distance of about 10 miles, between the position of a point plotted on this scale and series, and the position derived from another pair of photographs, taken with the large camera and set on K_2 and the Gasherbrums, between 30 and 42 miles away,

plotted on the scale of 1 : 250,000. This is only 0·2 millimetre on the latter scale.

In Mr. Hinks' description of the Autograph, he describes the various gears of the instrument, by which the different ranges of plotting are obtained. For this series we used the gears 1 : 1 for the distance and 3 : 1 for the foreground. One could of course only generalize the contouring of the Kyagar glacier. Mr Hunziker and I spent a happy and interesting afternoon with the Autograph index traversing the glacier, and I am more than ever prepared to take off my hat to the first person who succeeds in crossing it on foot. The best chance appears to me to be between the glacier and the marble cliffs, but it would mean probably at least three days' hard work with the axe to cut a track for climbers, and one may even then be held up by lakes. The snout here is about 2 miles across. Further up the glacier there are too many lakes and crevasses, to say nothing of the great ice pinnacles themselves, to render any passage practicable in its present condition, unless the eastern moraine is followed. This last leads to the eastern of the two Karakoram spurs, and from here a crossing appears to be practicable to the western promontory without excessive difficulty. But from this point the big glacier from Teram Kangri is a decided obstacle and much crevassed, though the pinnacles here are not more than 20 feet high. The western moraine does not look difficult, but it certainly will be most exhausting. The western side glaciers form obstacles, but by keeping to the main moraine for some way, the ends of these side glaciers can be passed. I think the whole passage by this route would take four or five days of strenuous work, and I recommend any one desirous of crossing to study the photographs in the stereoscope first.

The Autograph came out very satisfactorily from this test. The second experiment deals with the distant plotting. The longest base I could get for photographing K_2 stereoscopically was about 900 metres. Even with a base of this length, Gasherbrum I. was almost lost behind the foreground of the left-hand view. K_2 is 42 miles away from here, "Broad Peak" 37, and Gasherbrum II. 33 miles. That is to say, neglecting the inclination of the camera axes to the normal, the ratios of base to distance were 1 : 84, 1 : 74, 1 : 66 for these peaks. With this base, 2935·5 feet, to be exact, with the large camera, and with a measured convergence, we were able to plot the detail and the 250-foot contours of K_2 and the nearer peaks without much difficulty.

Combining my right-hand photograph here with another at W5, *i.e.* using a shorter base, 1054·1 feet, the ratios were reduced to 1 : 210, 1 : 185, 1 : 165, while Gasherbrum I. appeared now with a ratio 1 : 150. Though it was still possible to plot the summit of K_2 within a quarter of a mile, it was no longer possible to plot the detail either here or in the neighbourhood of the "Broad Peak." As however more detail could now be combined stereoscopically near the Gasherbrums, an attempt



Across the Kyagar Glacier and down the Shaksgam Valley

From Station W4. Focal length 165 *mm. Camera axis depressed* 6 *grades. Compare plate* 4, '*G. J.*', **69**, *p.* 301, *taken with focal length* 250 *mm. axis horizontal*

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Aghill Ranges and Gasherbrum I. from the Tatar La

From Station W.8.

was made to plot the contours also. It was found that they could only be plotted with extreme care, by joining up successive plotted points of the same height. I would therefore suggest that the ratio 1 : 165 is about the limiting effective ratio for the automatic plotting of detail.

In this series the heights of Gasherbrum I. and II. and of K_2 agreed within a few feet of the triangulated heights, after setting the Autograph height drum correctly for the Station heights and allowing for curvature and refraction. But Broad Peak appears in the Autograph to be only 26,400 feet in height, and not 27,132, as found by the Duke of the Abruzzi. If this peak had been at the edge of the plate, I would have given it the benefit of the doubt and assumed that either the instrument or I was at fault. But when controlled on both sides by such well-triangulated points as K_2 and the Gasherbrums for distance, direction, and height, an error of the Autograph is not possible. The height was checked at once by Mr. Hunziker, and we are convinced that this height, 26,400 feet, is correct within 50 feet, relative to K_2.

The other points of interest in this series are these. We were able to plot some of the great northern spurs of the Karakoram Range that enclose the Urdok and Gasherbrum glaciers. Neither the naked eye, nor the planetable, nor the Canadian method of photogrammetry could have found any detail whatever of these ridges, or could have even discovered their existence. They are rock and snow ridges against a background of snow and rock, and nothing but stereoscopy could hope to separate them or recognize individual points. In the Autograph these ridges stand out in wonderful relief and are easily plottable, thanks to the excellence of the objective and of the plates. I do not think that any of us quite believed that the Autograph would pick out these details, and Mr. Wild himself was certainly more than sceptical until he saw the diapositives in his stereoscope.

In this series we have also determined the positions of the snouts of two more glaciers beyond the Kyagar, and have plotted the bed of the Shaksgam far below any point we could see with the naked eye or without the magnification afforded by the Autograph. This point cannot have been more than a short distance from the spot reached by Sir Francis Younghusband, and must have been easily visible to him.

From the photographs taken from the Tatar La, we were able to contour the northern faces of K_2 and Gasherbrum I., and to obtain additional information in their neighbourhood. The detail joined up quite satisfactorily with that plotted from the Kyagar stations.

Another pair of photographs of this small-scale series is interesting. It was taken down the Sa Lungpa gorge, and at the time we were unable to identify for certain the distant peaks. We called them collectively "the Gasherbrums," but did not know which summits were concerned. After plotting the detail from the Kyagar stations we were able to identify the peaks in the Sa Lungpa pair, simply because four peaks fell on the

Aghil Ranges and Gasherbrum I. from the Tatar La

From Station H 15

plotted points and the heights agreed very well *inter se*. The three Gasherbrums concerned were II., III., IV. The Autograph was now controlled on these three peaks with the 1 : 1 gear ; the gears were changed to 3 : 1, and a good deal of extra detail was plotted along the peaks of the " Red Wall." We were, however, not able to trace the intricacies of the bottom of the Sa Lungpa gorges.

I must draw attention here to the correction necessary for refraction and curvature. The Autograph will not allow for this automatically. Mr. Hinks therefore worked out a curve for the necessary corrections, and Mr. Hunziker kindly converted this to a scale. This scale was used for the plotting of individual heights, and great accuracy was obtained with it. When setting the height drum for the plotting of contours, it was found quite accurate enough to divide the area into distance zones, each with a separate correction. With a little practice, this method of correction became quite rapid.

I will now turn to the last series. On my return through Nubra, the Khan Sahib's survey was closed at Panamik. We then marched towards Leh, and it occurred to me that I might improve the existing map by photography. The map is very much out of date, badly controlled by very few triangulated points, and the hills are very weakly and inadequately shown by hachures. I took four pairs of photographs on a long day's march near the Nubra–Shyok junction, noting only one doubtful triangulated point in all the four pairs and without being able to resect my camera stations. At each of these I observed a round of angles with the theodolite, including my base, the camera axis, the doubtful point, and other unknown points in the views. The result was quite satisfactory, and the Autograph map will on reduction fit over the existing map and greatly improve it.

I must admit that the success of all three experiments far surpassed my anticipations. I fully expected that with my very imperfect knowledge of the instruments before starting, something would go wrong. I made a certain number of mistakes through inexperience as it was, but the Autograph always found me out. On one occasion the camera trunnion was not correctly seated in its support. The error was made evident by a very bad " Vertical Parallax " in the Autograph. Mr. Hunziker worked out the various corrections for tilt, convergence, and base length, resetting the pair on its control points, and it was plotted quite satisfactorily.

I made one error in the identification of a control point. The Autograph immediately found me out, and the pair was plotted from controls obtained from its neighbour assisted by theodolite angles.

I made an error in setting the camera at the right-hand station, so that the control points were shown in the Autograph nearly twice as far from the base centre as they should have been. My base length I knew was correct, for another pair taken with the large camera from it had

plotted well, and there was no vertical parallax. This indicated an error in convergence and not in tilt. An arbitrary convergence correction was applied to bring the control points correct, and the whole pair plotted perfectly and joined up well with the surrounding detail.

I will now mention two additional tests that we made with the Autograph. We found that if we intersected a distant point with each eye separately in the stereoscope, and then examined the point stereoscopically with both eyes together, the index appeared sometimes just behind and sometimes just in front of the point. This indicates that however much one tries to intersect an ill-defined point separately, as, for instance, by planetabling or by the Canadian method of intersections, one does not do so; whereas if one makes use of stereoscopic fusion, the simultaneity of the operation ensures exactness of identification, and therefore enables intersection at larger distances for short bases, with much less possibility of error.

The other test was this: We found that we were able to combine in the Autograph a photograph taken with the smaller camera (focal length 165 mm.), at the right-hand station and depressed 6 grades, with another photograph taken at a left-hand station with the large camera (focal length 250 mm.), with the axis horizontal. We obtained perfect stereoscopic accommodation. I may add that there was no combination of photographs that we put into the machine that we failed to plot.

The experiments bring out certain points about the field work that are probably well known to those who are using the method regularly, but which I had no means of knowing beforehand. The most ideal conditions for field work may be summed up as follows:

(*a*) Stations should be higher than the ground surveyed.

(*b*) Camera axes should be depressed, in order to prevent too much dead ground.

(*c*) Camera axes should be inclined not more than 30° to the normal to the base, to get full advantage of the base length.

(*d*) The ratio of base to distance should be if possible between 1 : 10 and 1 : 30; but it is still *quite easy* to plot, if these are extended 1 : 6 to 1 : 60; and it is still *possible*, if the ratio is decreased to 1 : 160.

(*e*) Photographs taken across valleys are to be preferred to those taken up or down valleys. The former will have a more limited field of view, but will be far more complete than the latter, which will however be suitable if the method is only required for fixing additional control points.

(*f*) For contouring the flat bottoms of valleys, stations should be sited as high as possible, and the camera tilted down as much as possible. If low stations only are available, details of roads, etc., are apt to be obscured by trees, and the tracing of contours also becomes less exact, owing to grazing rays of observation.

(*g*) It is important that shadows should not be too heavy, and they should be approximately the same in the right- and left-hand views. Otherwise stereoscopic relief is not easy. For the same reason, dense featureless snow slopes on the negative are difficult to plot where the sun blazes on them and obliterates detail. Where in nature dense white slopes are combined with heavy dark rocks, it might be advisable to take two pairs of photographs with different exposures.

The success of all these experiments exceeded our expectations. This is no doubt partly because of the climate and atmosphere of the Aghil ranges; but there is no doubt that it is mainly due to the excellence of the design of both the field and the office apparatus. At the same time I cannot close my paper without saying that the accuracy of Colonel Montgomerie's triangulation of the great peaks seventy years ago enabled us to prove the value of this new method to-day.

Before the paper the CHAIRMAN (Colonel Sir CHARLES CLOSE) said: There are not very many more interesting developments in the survey world than that of stereophoto surveying. Major Mason, as we all know, has been out to the Shaksgam country and has there had a great opportunity, of which he has taken full advantage, to test this method, and he has recently been to Switzerland to make use of Wild's machine for the automatic plotting of his maps. He is now to tell us all about it, and I think that we shall all find that we have something to learn, and that the method is likely to be the starting-point of a new system of survey. With those few remarks I will ask Major Mason to read his paper.

Major Mason then read the paper printed above, and a discussion followed.

The CHAIRMAN: We are anxious to have a full discussion of this communication. I will ask Colonel Sackville Hamilton, who was in Switzerland with Major Mason, to speak first.

Lieut.-Col. SACKVILLE HAMILTON (Survey of India): I am disappointed not to hear Mr. Hinks give his description of the instrument, as I had the good fortune to be with him in Switzerland. I can assure you the instrument is extraordinarily good. I went to Flums prepared to be sceptical, but I have been much converted so far as ground survey is concerned. The thing that struck me most was the fact that Major Mason was able to contour K_4 at a distance of 42 miles. That, he has admitted, is due first of all to the excellence of the Wild objectives and of the Imperial plates. But I think we ought also to pay a tribute to the accuracy which Major Mason himself must have brought to his work. Future users of the method must not think that they are going to be able to do photogrammetric survey at 40 miles' range, because they cannot. A great deal of the success achieved is due to the wonderful clearness of the atmosphere in the Karakoram, where Major Mason has been working. You cannot expect that in other places. Personally, I am of opinion that 10 to 12 miles is the most we may expect.

While we are on this subject I think it would be interesting to discuss costs. It ought to be realized that this method is a going concern in Switzerland. There are two firms, Dr. Helbling's at Flums and another at Berne, turning out work by this method. Dr. Helbling has work in South America on the

Cordillera Railway, and has also contracted for work in Asia Minor for railway concessions. The machine is also doing other large-scale work, and remember for the present it is really a large-scale instrument. As regards costs, I discussed these with Dr. Helbling before I left Flums, but it is extremely difficult to give any accurate figures. It depends so much on the actual negatives, what detail is required, the area covered, and so on. The autograph costs in Switzerland £2800. When I asked Dr. Helbling as to rates for work which we ourselves might wish to send him, he told me that the use of the Autograph, including the pay of the two operators and overhead charges, would be 300 Swiss francs per day; that is, provided all the data be given to them already worked out in rectangular coordinates, heights in metres and angles in grades, and work can be commenced with the machine without increased labour for their computing staff. Given that, Dr. Helbling estimated in respect to ground survey only, assuming that the greater portion of each of the pairs of negatives contained useful detail which was required to be plotted, that in an eight-hour day they could plot five pairs per day on the scale of 1/20,000; four pairs on the scale of 1/50,000; three pairs on scales of 1/100,000 to 1/150,000; two on 1/200,000; and one pair on the scale of 1/250,000. That, of course, is a rough estimate: it might be more and it might be less.

The number of pairs of photographs given as being plotted in one eight-hour day is the maximum number for each particular scale that can be set and adjusted and fully exploited in the machine in that time. Nothing has so far been done with this Autograph on photographs taken from the air, but it is readily and easily adjustable to this interpretation.

Col. C. H. D. RYDER: I personally must honestly admit that I am a dreadful conservative. In connection with Col. Hamilton's remarks as to costs, what we really want to know is the cost of the instrument, of the intelligent and practical surveyor who is going to work it, the people who are going to make the result into maps; and then we have got to compare that with the cost of other methods. In India we all swear by the planetable. We have very cheap and good surveyors who do a lot of planetabling. There are of course, as one finds from an expedition to the Shaksgam, certain areas which it would be practically impossible to get at with a planetable. Nevertheless, I think that the planetable will remain supreme for the greater part of explorers' work; and that this sort of instrument or photography of some kind should really be looked on as a supplement to regular survey work, that is, as regards the photographic part. I was very glad to hear Major Mason say that the theodolite part of the instrument was first-class, and his certificate that he would sooner use that than any ordinary theodolite is a distinct recommendation in favour of the instrument as a theodolite. Major Mason is an enthusiast on the subject, and he has given us a very interesting description of the instrument. I know the method is in its infancy, but Mr. Hinks, Major Mason, and Col. Hamilton all went over to Switzerland and all spent a month either learning or improving their knowledge and working up a map. Well, those are three very able gentlemen, and one wonders whether, taking into account the amount of intelligence used and the value of their brains, we could attain equally good results with the ordinary old wooden planetable, except in those exceptional cases where you cannot get near the object.

Col. E. M. JACK (Ordnance Survey): Major Mason has answered a number of queries raised in regard to the photo-theodolite last year, but there is one point that was raised, I think at the discussion or afterwards, that he will perhaps give his opinion on, and that was the question whether it was really sound to

combine the theodolite with the camera in one mounting. I know that the opinion was expressed that it was unsound; that it was better to have the theodolite entirely separate from the camera. Major Mason has had a good deal of experience now, and I should rather gather that he has found no disadvantage. In the experiments that were carried out I think we have to remember, as Col. Hamilton said, that the atmosphere was extraordinarily clear and also that the whole of that country is, apparently, rock, snow, and ice. I wonder what the effect would be in a country where the atmosphere was less clear? Would there be merely a limitation of vision so that you could not work at such a great distance, or would there be any other effect? Also, what would be the result of attempting this method in country covered with forest? About the cost of the method, I think Col. Hamilton and Col. Ryder have both rather anticipated me. We of course must know more what the costs are, and we have got to come down to hard facts. We must know what would be the cost of this method per square mile as compared with other methods. Although this method is, for survey on small scales, in its infancy, I think surveyors while being conservative should at the same time be enterprising and entertain all possibilities. We have been shown quite clearly that there are most extraordinary possibilities in this method, and while at present I quite agree with Col. Ryder that it must be auxiliary to our old methods, we may find, of course, eventually that it will supplant the older methods, and I think we must be prepared to accept that. Otherwise I have only to say that it seems to me quite extraordinary that Major Mason has obtained the results he has with these very small bases; it is quite a remarkable thing. That he has such wonderful results is, I believe, partly due to the clearness of the atmosphere, but cannot be put down wholly to that. I should like to congratulate him very much on a most interesting paper which I have enjoyed immensely.

Mr. HOTINE (Geographical Section, General Staff): I have little to say beyond adding my thanks to Major Mason for his paper. I do not think there can be much doubt as to the value of the Wild Autograph in large or possibly medium scale photographic surveys from ground stations. It has also been designed to allow of its use for air photographs; but there it has yet to be proved. In dealing with air photographs, what Major Mason referred to as his mistakes are the rule rather than the exception, and it was illuminating to hear his remarks on the subject of trial and error setting in the few cases where he did make mistakes. Major Mason remarked that the rectification of his mistakes was helped on by the observation of what he called "height parallax." That is a literal translation from the German of a property known to us as "want of correspondence," and it is the only indication by which we can, without a dense ground control, rectify the "mistakes" occurring in air photographs. Unfortunately, the particular movements of the Wild machine are not entirely suitable for correspondence setting. So far only one machine has been designed which introduces movements suitable for this purpose, and that is not yet in the experimental stage.

Col. H. L. CROSTHWAIT: I am afraid I have not had any experience of this kind of surveying, but there are one or two points I should like to ask Major Mason. All the photographs he has shown us have been of mountainous country. It do s not seem to me that you could apply this system to any but hilly ground. Col. Hamilton raised the question of cost. Has the cost rate per square mile been worked out? You might have a pair of photographs that had a great deal of ground in them; you might have a pair with a lot of

dead ground which would have to be gone over by the ordinary planetabling methods in order to fill it up. Perhaps the system has not gone far enough to enable us to estimate what the cost per square mile would be on an average. I should like to congratulate Major Mason on his paper, which I think has been very interesting to all present.

Mr. HINKS: I have been described to-day as an enthusiast, and therefore you will allow me to express, without shame, my great enthusiasm for the results of the experiment that Major Mason has made. He has told you how we had been in correspondence for a long time before the Shaksgam expedition started. I was partly responsible for reporting to the Council upon the desirability of doing what Major Mason asked: "Can you, if you are going to make a contribution to my expedition, provide me with the instruments for stereo-survey?" I think almost everybody who has heard the paper this afternoon will be very glad that the Council were able to do that, and will congratulate Major Mason upon the striking success of the experiment. Unfortunately, at present there is not in this country any machine that can deal with the stereoplotting of the beautiful pictures that Major Mason has taken, and therefore we had to arrange to work them up upon the Autograph. I was not at Flums for the whole month. I left England on April 6, and found Col. Hamilton and Major Mason well established at Ragaz, near by. They had kindly saved up one or two rather troublesome little problems to occupy me on my arrival, one of them being how we were going to correct these pictures at a distance of 60 or 70 kilometres for the curvature of the Earth and refraction. At a distance of 70 kilometres the correction to the measured height of K_2 referred to the base station ran up to something between 300 and 400 metres. A thousand feet had to be added to the measured height of K_2 to allow for the combined effect of refraction and curvature. One might have expected that there would be some difficulty in deciding upon the coefficient of refraction to be used. I think we made a happy and fortunate shot, for we were able to establish a table of corrections at this great distance which, as it proved, worked very well. The first time we tried it we determined the height of K_2, which came out at the triangulated height within 1 metre! Of course, that would not happen every time. It is what happened on that occasion, and it much cheered us up.

I never had a more difficult task set me than to write an intelligible description of the maze of complicated movements in the Autograph, to get the geometry of it all clear, and to show how the thing worked in all the various cases of inclined and convergent plates. The genius of Mr. Wild has succeeded in getting into a very compact space an instrument that will deal with all those various complications. I cannot think anybody would welcome an attempt to describe the mechanism this afternoon, especially the device of the double cam which is unique in Mr. Wild's instrument and is, as far as I know, understood by Mr. Wild himself and by nobody else. We have got some way towards understanding it, but when I tell you that the double-cam motion has to give motions to the plate which are comprehended in two trigonometrical expressions, one of which involves the square root of the product of a sine and a tangent, you will see that the mechanism of that motion requires a little care. I will not attempt to describe the instrument, but will ask those who are impatient to know about it to exercise their patience and wait until the description is published in the *Journal*.

Before going on to deal with one or two points, I should like to associate myself with Major Mason in expressing our most sincere gratitude to Dr.

Helbling, who, in the midst of his very important and also very lucrative work for the railway companies, considerably disorganized his establishment in order, out of a real scientific interest, to make these experiments in survey upon a scale totally different from what he had ever worked on before. We are indebted equally to Mr. Hunziker, his chief engineer, as well, of course, as to Mr. Wild in the first instance.

I do not think that Major Mason, perhaps, quite sufficiently emphasized the fact that this was the first experiment made with these instruments upon geographical scales. They normally work upon the scale of 1/2,000, and then make a combined reduced sheet upon the scale of 1/20,000, as you see on the Argentine Railway surveys. Being geographers, we were not so much interested in scales of 1/2000 or 1/20,000, but in scales of something like 1/200,000, and it is that work upon the small scales that has been so successfully accomplished though never tried before, so that the method is justified as a geographical and not a purely engineering method.

But one must not forget that there are certain things that geographers will want to be done upon those larger scales. When I first talked about the uses of this instrument I suggested that it would be extraordinarily interesting and important to survey very carefully certain areas that were liable to considerable denudation, such as Wastwater screes and Striding Edge on Helvellyn, and to establish now, correct within a few inches, a contoured map, so that it can be compared in one hundred years' time in order to see what has happened in the way of denudation. A similar question which could be most readily studied by the use of these machines would be to measure the changing volume of glaciers. It would be easy to contour glaciers, or to make a sort of integrator attached to the instrument and to measure the difference of volume from one year to another. An accurate estimate of the volumes of glaciers in India would be not only of scientific interest to India but, more important, of real, almost commercial interest, because it would indicate how fast the storage of water is changing.

We have heard a most interesting account from Col. Sackville Hamilton of an estimate of the costs, not of course in exactly the form in which a Surveyor-General would require to look at it. I take it—and this point Major Mason did not mention—that the Swiss Federal Topographical Survey having decided to re-survey the whole of Switzerland by this method shows that the costs are, at any rate, well within the power of such surveys to meet, and that they consider the expense well justified.

In particular reference to something Col. Ryder has said I would, with some strength, repudiate the suggestion that probably the amount of work represented in those three sheets was not worth the time of two senior officers of the Survey of India and one amateur enthusiast. It seemed to me a grossly unfair comparison. After all, when you are proposing to take up a new method it is presumably worth while for the Director of the Survey or some of his senior officers and advisers to devote a part of their time to studying the method in its inception and to discover whether or not it is worthy of adoption. The value of the time spent in preliminary experiments is surely not to be charged to the cost of the first results. But whether or not the method is economical for a regular survey I do not think matters to this Society. I would suggest that there are possibilities to geographers which are of inestimable value: the possibility of being able to secure material in rare circumstances in the course of a few days, such as on the expedition in the Shaksgam, to which you can devote as much labour as you like when the results have been success-

fully brought back to this country. Therefore any arguments as to whether it is worth while to adopt this method on the Ordnance Survey or the Survey of India for ordinary work has very little relevance in the case of us geographers, because the result you can obtain by seizing a rare opportunity may be quite inestimable. It would be undoubtedly expensive to introduce this machine into the country; but I believe the results Major Mason has shown you make you, or at any rate many of you, hope that some means may be found by which we shall be able to get the necessary number of thousands of pounds to establish one of the Wild Autographs here in the Society, and to undertake to work up plates contributed by geographical expeditions in distant parts of the world.

Major MASON: The first point is one which Col. Sackville Hamilton brought up. I quite agree with him that in a country where there are clouds and mist you cannot survey up to 40 miles. But there are many countries in the world where you do get a clear atmosphere, and then you can. In Switzerland they only plot up to about 15 or 16 miles, owing to the climate, which is really unsuitable. Nevertheless the Swiss topographical maps by the new method answer many points raised this afternoon. I did not mention them because I was speaking about the Shaksgam. The work in Switzerland brings out the advantages of having the camera and theodolite mounted together. The very small loss in accuracy is fully compensated by the great saving in time and transport. I had a second theodolite with me on the expedition. I left it behind at the depôt to save transport, and found the Wild instrument ample.

Wooded country can be plotted on these small scales. But on large scales, say 1/2000, the height of the trees is a difficulty. For small-scale work you can make your index traverse among the trees, and estimate the bottoms with an inappreciable error. I had a simple example of it in the scrub country in Nubra. The question raised about accuracy of detail is answered well by comparison with the old and new Swiss surveys. If you look at the two displayed on the wall, you will see that one is accurate and the other inaccurate: at least, the two are certainly by no means the same. The Swiss Government were so astonished that they had a comparison made by their own surveyors on the ground. In every point of difference the Autograph map was correct, and the old planetable survey was wrong. And look how wrong it is! In some spots features are omitted and in some the contours are at right angles to their true direction.

Doubtless the new method has limitations: so has every method of survey. These limitations are fully recognized by those who are making it a commercial success. In Switzerland they do not attempt to make a complete map by this method alone. They take photographs and plot from these all the detail and contours that they can, economically. A few small gaps remain, actually 5 per cent. in the example shown. Then a planetabler, one man only, goes out and completes the map and fills in the gaps and names. This is more economical than surveying every gap by photography, and the planetabler now has a very good control for his small gaps. The combination is more economical and more accurate than planetabling alone.

One other point. Swiss maps are plotted on the 1/25,000 scale, and reduced to 1/50,000. This has been criticized as uneconomical. But if you think for a moment, it is not so. The Autograph operator works at the same pace, whatever the scale. But on a large scale the pencil moves faster and more regularly. It is like an efficient draftsman compared to a slow worker. With

the large scale, by the use of gears, one can plot nearer the base centre than on small scales. There are also other advantages which need not be mentioned.

Cost of course, in these hard times, must be taken into consideration. But surely it is no good paying any money at all for an incorrect map. I feel fairly confident that a survey department that neglects now to make maps as accurate as modern methods allow, will in a few years find its maps as out of date as the old caterpillar hachured maps are to-day.

The CHAIRMAN: I think most of those who have listened to this discussion and Major Mason's excellent lecture will have come to the conclusion that the method is here to stay. We may be rather slow at taking up a thing, but eventually we shall be as well equipped as other countries are now. It was not mentioned that there are several machines of different types. There are two Zeiss machines in Madrid at present working commercially, and when I was there a year ago they were making a map of Bilbao. I think most of those present are convinced that we have to study this method not only because it gives us the means of making surveys in positions where otherwise it might be impossible, but also because, ultimately, we shall get even more accurate surveys than we have now, and certainly done with greater facility. I was struck by Major Mason's account of the machine finding out if mistakes had been made. It rather reminds me of the story of Babbage's machine. It was said that his machine, when it wanted a logarithm, used to ring a bell. You put a logarithm in. If you put the right one in, everything went well; if you put in the wrong one, the machine ground away for some little time and then spat the logarithm out! However, seriously, we have had an excellent account by Major Mason of the fruits of an admirable expedition. I am sure the results are worthy of the expedition, and I do not think I can say more. In your name I thank Major Mason most heartily for his paper.

AN ATTEMPT TO DESCRIBE MR. WILD'S STEREOPLOTTING MACHINE—THE AUTOGRAPH

Arthur R. Hinks, C.B.E., F.R.S., Sec. R.G.S.

Folding plate follows p. 416.

Introduction.

IN the discussion following Major Mason's paper on the Stereographic Survey of the Shaksgam I related briefly the circumstances in which the following paper was written. While Major Mason and Mr. Hunziker were plotting the Shaksgam plates on one of the Autographs established in the Vermessungs-Bureau of Dr. Helbling at Flums, it was my task to study and attempt to describe the theory and construction of the instrument, so far as is necessary for understanding the principles of Mr. Wild's solution. Mr. Wild himself has not as yet published any account of his machine; but its theory has been described in general terms by Mr. H. Härry in a useful collection of papers read at the meeting of the Schweizerischer Geometer-Verein at Zurich in May 1926 and published under the title: *Die Photogrammetrie und ihre Anwendung bei der Schweizerischen Grundbuchvermessung und bei der allgemeinen Landesvermessung* (Brugg. 1926). A rough translation of this paper,

kindly made for me by the Reverend A. J. Potter, of the Society's library staff, removed some of the difficulties of unravelling a very complicated subject described in rather complicated German, and enabled me to arrive at Flums with a preliminary knowledge of the geometry. Mr. Hunziker then very kindly lent me a carefully written and beautifully illustrated typescript which he had prepared for use in Dr. Helbling's bureau; this was of great assistance in understanding the mechanical and optical details, many of which are hidden. On a visit to the factory of Mr. Wild at Heerbrugg I was able to see a machine in process of assembly, and to learn from the inventor the trigonometrical formula in which a principal secret of the machine is embedded. As my account was gradually put together the description of the mechanism was criticized to its great advantage by Colonel Sackville Hamilton, and Major Mason contributed many important remarks on the use of the instrument. Whatever small merits the following account may have are greatly due to the gentlemen I have named.

1. The Autograph is designed to plot and contour from pairs of plates taken with the Wild Photo-theodolite. In what follows we shall assume that we know the length and azimuth of the base; the azimuth of the camera axis at both stations, that at the left-hand station being taken as principal in case of convergence; the tilt of the axis to the horizontal, that at the right-hand station being principal in case of different tilts (rare in terrestrial stereography); the co-ordinates and height (in metres) of both stations and of the control points (two or more) on the projection selected for the map, with the heights above mean sea-level.

In this description it is convenient to speak as if the plates in the field were taken by two field cameras at the R.H. and L.H. stations, which cameras were afterwards transferred to the Autograph. In practice the same camera is used at the two stations, and the autograph cameras are very nearly identical with it. Provision is actually made for the very slight differences in focal lengths of the objectives in the field camera and the autograph cameras, but we may here neglect it. What we call the autograph cameras are really skeletons of the same dimensions as the field camera, and carrying identical reference marks, to which the plates taken in the field camera are adjusted.

2. Take then the following standard notation:

b is the length of the base in metres.

h is the height in metres of the L.H. camera station above the R.H. station.

ω is the obliquity of the axes, defined as the angle between the normal to the base and the horizontal projection of the optical axis of the camera: if the projected axes of the cameras are not parallel at the two stations ω_1 is the obliquity for the R.H. station, and ω_2 for the L.H.

θ is the tilt of the camera axis to the horizontal, or θ_1 and θ_2 if the tilts are not the same at the two stations.

As defined above ω_2 and θ_1 are taken as the standard obliquity and tilt when the camera axes are not parallel at the two stations.

f is the focal length of the camera in metres.

3. At any camera station let

$\pm\alpha$ be the azimuth of any point P on the ground measured right or left from the horizontal projection of the optical axis.

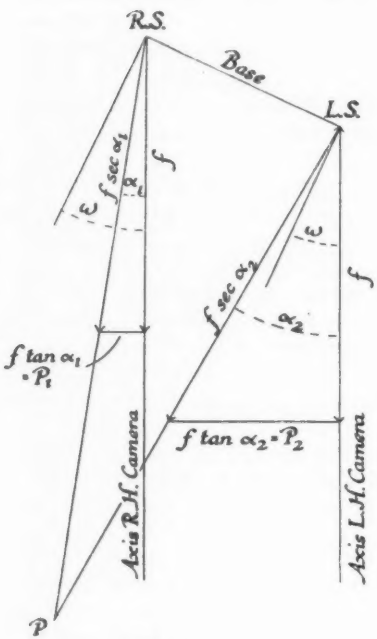


Fig. 1

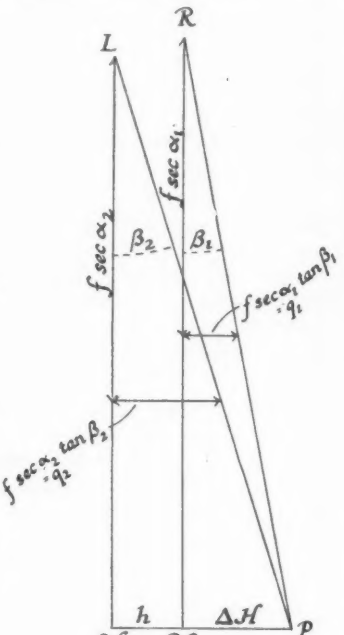


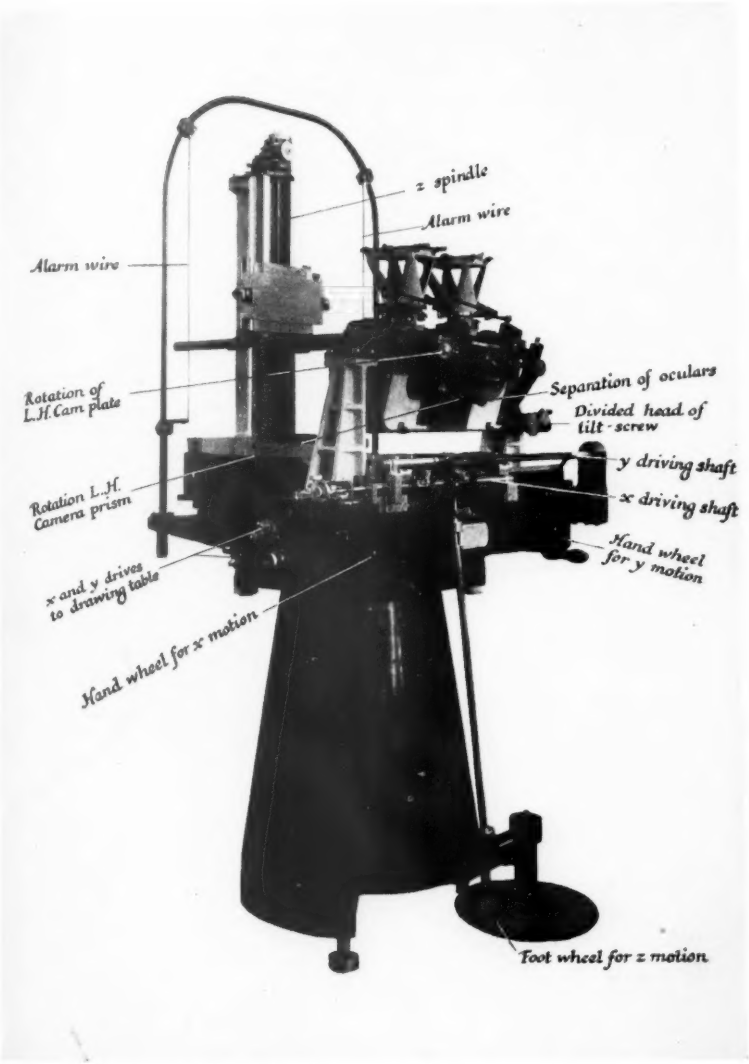
Fig. 2

$\pm\beta$ the angular elevation or depression of the point. Then if the camera axis is horizontal, the rectangular co-ordinates p, q of the image of P on the plate are given by

$$p = f \tan \alpha \qquad q = f \tan \beta \sec \alpha$$

The relations between the angular and plate co-ordinates may be shown geometrically thus:

From figure 1, given b, ω, α_1, α_2, and f, we construct $f \tan \alpha_1 = p_1$, and $f \sec \alpha_1$ for the R.H. station, $f \tan \alpha_2$ and $f \sec \alpha_2$ for the L.H. station, and the distances (horizontal) of P from the two stations.



Oblique front view of the Autograph

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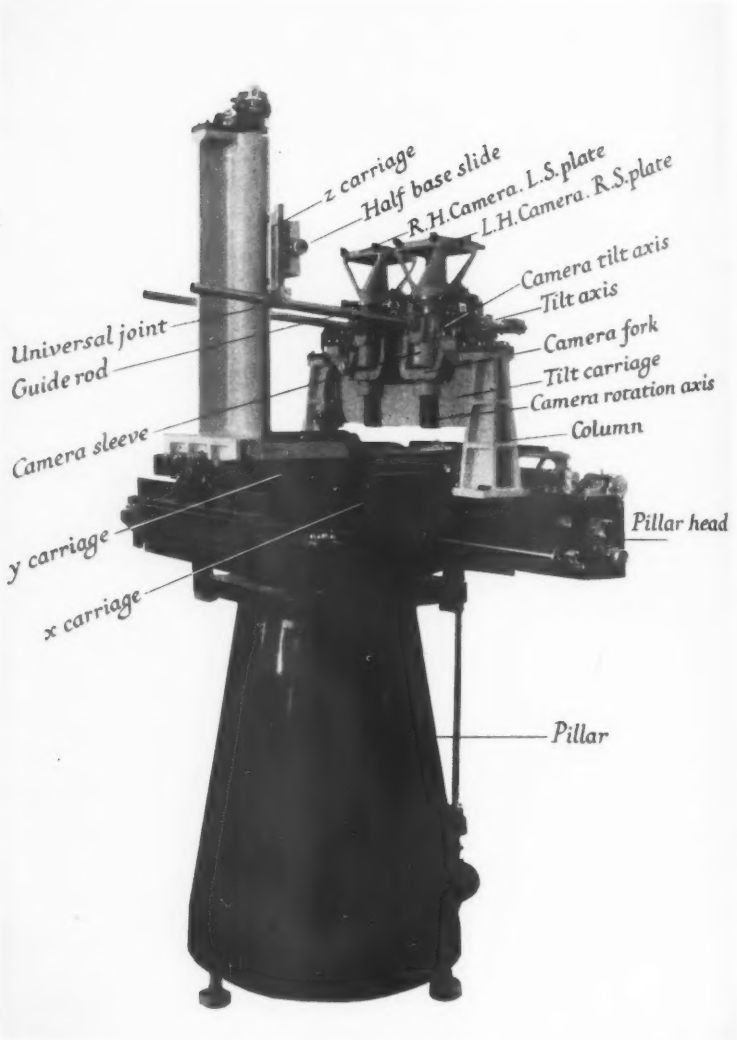
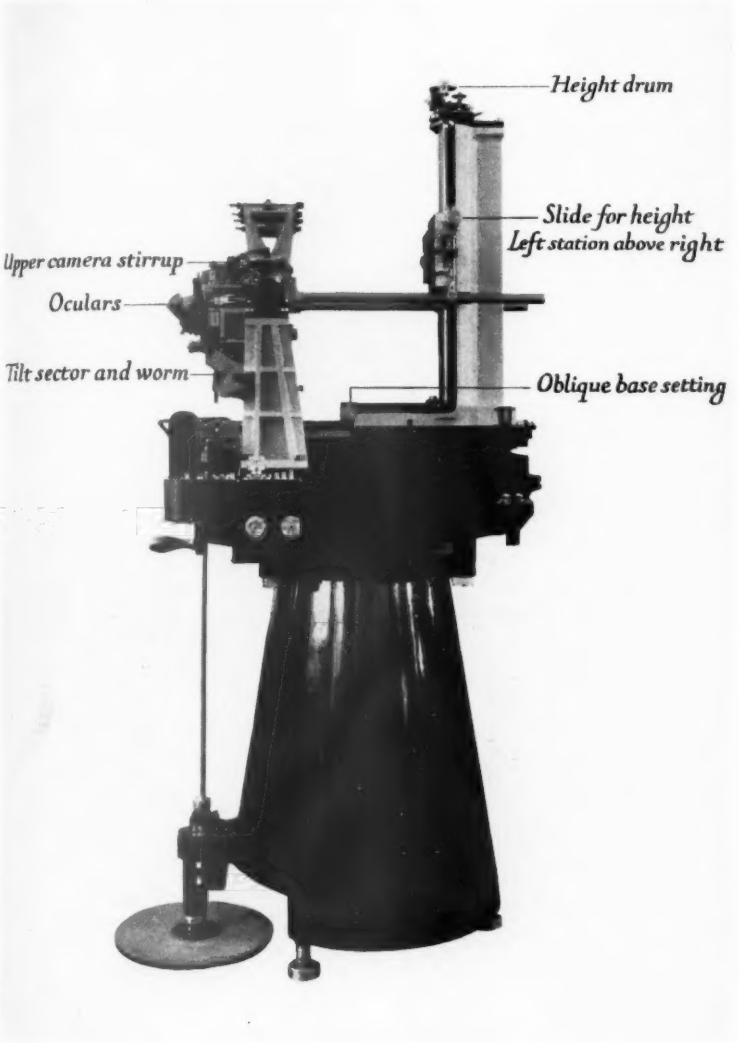
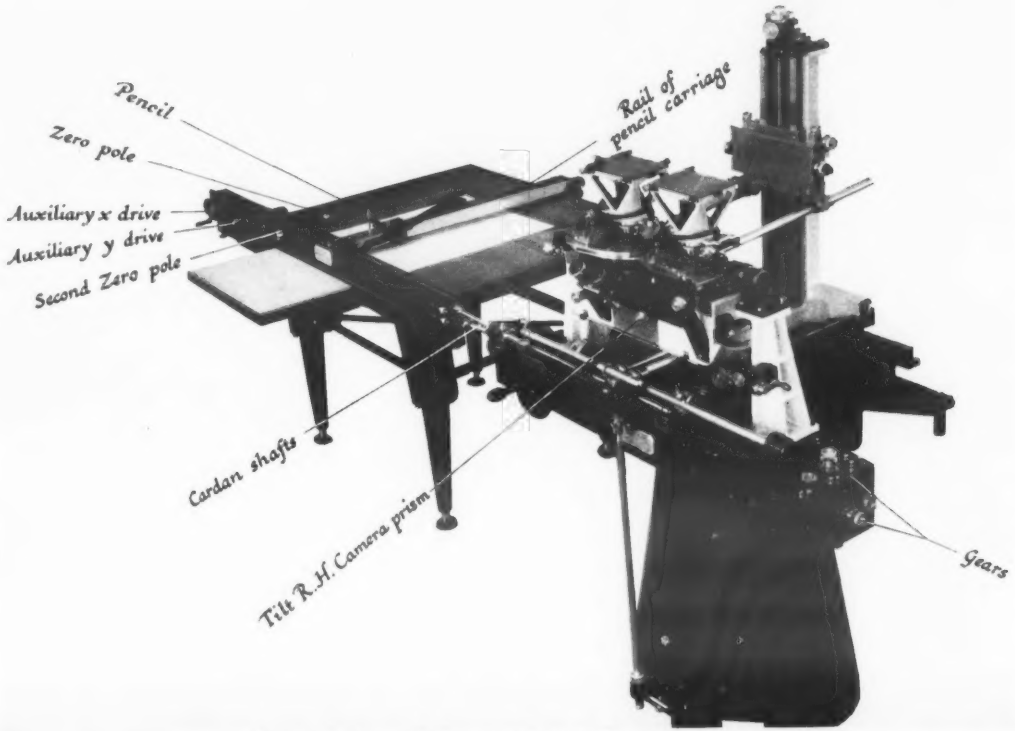


Oblique back view of the Autograph



Side view of the Autograph



General view of Autograph and Drawing Table

Then in figure 2, taking RM = RP from Fig. 1, and setting off MP = ΔH, the difference of height above M.S.L. of P and R, we have β_1, and thence $f \sec \alpha_1 \tan \beta_1 = q_1$.

Similarly, setting off h the vertical interval of L below R, and LN the hor. dist. from Fig. 1, we have β_2 and $f \sec \alpha_2 \tan \beta_2 = q_2$. These relations will be found useful later in constructing the figures to illustrate plotting by the Autograph.

4. The principal parts of the Autograph are:

The conical pillar, on three levelling screws, supporting the **pillar-head.**

The pillar-head carries two horizontal leading screws, turned by hand wheels, and parallel rails for the **x-carriage,** which is geared to the leading screw operated by the left-hand wheel, and moves in a horizontal plane parallel to the front of the pillar-head.

The x-carriage carries a pair of rails at right angles to this, on which the **y-carriage** is moved in a horizontal plane by gearing to the leading screw operated by the right-hand wheel.

The y-carriage carries a vertical column enclosing a guide rod and leading screw geared to the foot wheel, by which the **z-carriage** is moved vertically.

The z-carriage can be rotated about the vertical guide rod by an arm actuated by the oblique-base setting screw. It carries two **universal joints on base slides** which can be moved outwards horizontally by measured amounts in opposite directions. The right-hand joint (as seen from the front) can also be moved vertically by measured amounts on the z-carriage.

Tubular **guide rods** slide through these joints to the cameras. At the top of the leading screw on the z-carriage is a counting mechanism (**height drum**) which records the vertical motion of the carriage, and by change of drums for different gears records in a great variety of scales. If the carriages are turned too far the guide rods touch the **alarm wires** and ring an electric bell.

Near each end of the pillar head, in front of it, and beyond the range of the x-carriage, are two bearing columns which carry the trunnions of the **tilt axis,** horizontal and parallel to the direction of x, the **tilt carriage** being rotated on these trunnions and held by the **tilt sector and worm.**

The tilt carriage carries the two **camera rotation axes,** parallel to one another, vertical in the normal position (when the plates are taken with optical axes horizontal), and at fixed distances apart equal to the distances between the universal joints of the guide rods when the base slides are set to zero. The tilt carriage also carries the **binocular telescope,** and the **horizontal cam plates** (both to be described later).

The camera rotation axes carry the **camera forks,** which in turn carry the bearings for the **camera tilt axes** (normally horizontal),

whose trunnions are borne on the tubular **camera sleeves**, to which the guide rods are rigidly attached. When the instrument is set to zero these three sets of trunnions (*i.e.* for tilt carriage and two cameras) are co-axial.

The upper parts of the cameras are skeleton frames which carry the plate-holders, in which the fiducial marks on the plates can be adjusted by screws to the corresponding marks in the holders. The lower parts of the cameras are tubes rotating in the camera sleeves on collars. These tubes carry the objectives.

The camera rotation axes and the camera tilt axes intersect in the first principal points of the camera objectives, and form universal joints about which the cameras can be turned in any direction by the guide rods whose axes also pass through the principal points.

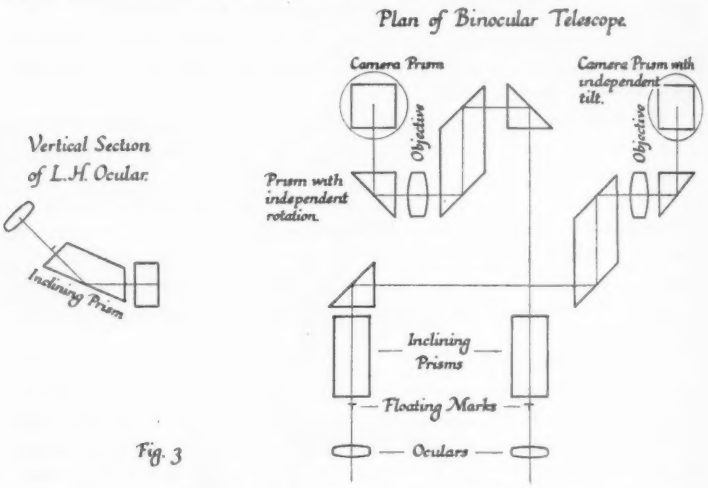


Fig. 3

The camera sleeves also carry the 45° reflecting **camera prisms** so placed that in the zero position a central vertical ray passing out through the camera objective is reflected horizontally in the y direction towards the front.

The camera can be turned in its sleeve independent of the guide rods by the **upper stirrup** which terminates in the **stud** moving on the **vertical cam** (see later). The camera sleeve carries **the lower stirrup** which is extended to carry the vertical cam and the arm guiding it by the **horizontal cam** in the horizontal cam plate. The function of these cams will be described later.

The binocular telescope is carried on the front of the tilt carriage. The approximate diagram (Fig. 3) shows that in the normal position the line of sight is directed downwards at 45°, and that the L. and R. oculars observe the R. and L. cameras respectively. The lengths of path in air

and glass respectively are the same in the two telescopes, which are focussed on infinity with axes parallel, looking in the y direction into the camera prisms. The R.H. component can be moved in the x direction to allow for a range of interocular distance from 60 to 75 mm.

5. Suppose now the base slides be set to zero, the L.H. guide rod set horizontal with a striding level, the x-carriage set to zero, the tilt carriage also to zero, the y-carriage at y (which will in this position be the distance between the centres of the universal joints on the L.H. rod). Now give the x-carriage a displacement x. The guide rod, camera, and camera prism turn through an angle $\alpha = \tan^{-1}\frac{x}{y}$ in a horizontal plane, and the line of sight of the R.H. telescope sweeps along the p axis of a plate in the L.H. camera to a distance $f\tan\alpha$ from the centre. If on the other hand we had lowered the z-carriage a distance z, instead of moving in x, the line of sight of the telescope would have swept the q axis on the plate to a distance from the centre $q = f\tan\beta$, where $\beta = \tan^{-1}\frac{z}{y}$.

Now suppose the two movements combined. The camera has been tilted on its trunnions through an angle β and rotated with its sleeve through an angle α. It is easy to show that the telescope is directed to a point P′ on the plate whose co-ordinates are

$$p = f\tan\alpha\sec\beta \qquad q = f\tan\beta$$

On the other hand, suppose that a field camera had been set up directed parallel to the y-axis, to photograph a point whose direction from the first principal point of its objective is parallel to the left-hand guide rod. Then the co-ordinates of the image P of that point on the plate will be

$$\mathrm{P} = f\tan\alpha \qquad \mathrm{Q} = f\tan\beta\sec\alpha$$

Hence, with the movements so far described, the point P′ to which the telescope is directed does not correspond with the point P in the field of view of the field camera; and if at the R.H. station we had photographed a point in azimuth α, elevation β, transferred the plate to the left-hand autograph camera, and moved the hand wheels so that the L.H. guide rod took up the same azimuth and elevation with respect to the y-axis, then the R.H. telescope would not be directed upon the point P, but on the "False Point" P′.

A fundamental feature of the Autograph is the mechanical device by which this error of projection is corrected.

6. It is easy to show (see Appendix) that the false point P′ and the true point P are at the same distance from the centre of the plate. Hence a rotation of the camera in its sleeve, the sleeve and camera prism remaining fixed, will bring P on to P′. It is also easy to show that the angle ρ by which the camera must be rotated is given by the equations

$$\sin\rho = \frac{\sin\alpha\sin\beta}{1-\cos\alpha\cos\beta} \quad \text{or} \quad \tan\rho = \frac{\sin\alpha\sin\beta}{\cos\alpha+\cos\beta}$$

and the directions of rotation are as shown by arrows in the four quadrants (Fig. 4): for a point in the extreme corner of a plate 15 × 10 cm. and focal length 16·5 cm. the value of ρ is about 3° 15′. This rotation is given to the camera by a system of cams which Mr. Wild has not yet described. Superficially the construction is as follows:

The cam plate (Fig. 5) is carried by sleeves on the tilt axis, and supported by the tilt carriage. In the normal position it is horizontal and lies a little below the tilt axis. In this plate is cut a cam-groove, made up of two circular arcs of radii C_1D and C_2D about 15 mm. greater and less than the distance from the junction D of the arcs to the tilt axis. A lower stirrup carried on the camera tilt axis is prolonged to carry a pillar E perpendicular to the cam plate. Upon this pillar a cam-block rides with a rigid arm carrying a stud (D) which slides in the cam-groove. In

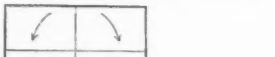


Fig. 4

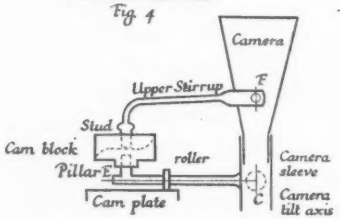


Fig. 6 Elevation

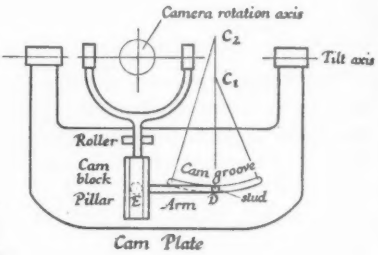


Fig. 5 Plan

the normal position CE is parallel to C_1C_2D, and ED parallel to the tilt axis.

When the camera is turned about the camera rotation axis C by the guide rod, through an angle α, ED moves nearly but not quite parallel to itself, since the stud is moving on circular arcs of slightly different radii from the radius CE. Hence when E moves to the right the cam-block turns a little counterclockwise, and when to the left a little clockwise, with a range of 2 or 3 degrees at most on each side of the normal.

An upper stirrup, carried on trunnions on the camera (Fig. 6), is prolonged to a stud which slides in the cam-block, on the cam which is shaped somewhat as the dotted line. When the camera is vertical the stud is centrally over the pillar E, and a rotation of the cam-block on this pillar does not displace the stud. But when the camera is tilted right or left through an angle β, the stud is moved correspondingly through a horizontal distance along the cam-block of the order of CF $\sin\beta$; and if the cam-block has been turned a little on its pillar, the stirrup is constrained to move sideways and the camera is turned a little in its sleeve.

During a recent visit to Heerbrugg Mr. Wild has kindly informed me that the expression for the requisite rotation of the camera ρ is

$$\tan\rho = \frac{\sin\alpha \sin\beta}{\cos\alpha + \cos\beta}$$

which may be written 2 $\tan\rho = (\sin\alpha \tan\alpha)^{\frac{1}{2}} (\sin\beta \tan\beta)^{\frac{1}{2}}$ to a close approximation, and it is shown in the Appendix that this is true if we can neglect terms of the order $\sin^4\frac{\alpha}{2}$ and $\sin^4\frac{\beta}{2}$. But it is not easy—at least for me—to see how the combined action of these cams produces a rotation through an angle whose tangent is defined by such a curious expression.

There is however no doubt whatever that the operation of this cam system does eliminate the error of projection explained in § 5, with a high degree of success; and that its invention is responsible for the relative simplicity and compactness of the optical system of the Autograph.

The cam plate has been described above as carried on the tilt axis independent of the tilt carriage. This is necessary only for the R.H. camera. If the tilts of the plates are different, θ_1 and θ_2 as defined in 2 for the R. and L. stations, then the tilt carriage is set to θ_1, and the R.H. camera prism and cam plate are tilted on the tilt carriage by an amount $\theta_2 - \theta_1$, which requires that the R.H. cam plate shall be carried independently on the tilt axis.

Similarly, if the camera axes are convergent, the obliquity at the left station ω_2 is taken as standard, and the 45° prism between the objective of the R.H. telescope and the camera prism of the left camera (containing the R.S. plate) must be rotated through an angle $\frac{1}{2}(\omega_1 - \omega_2)$, while the cam plate above must be rotated in its own plane through an angle $\omega_1 - \omega_2$.

7. We have now shown that the optical axis of either telescope, defined by the line of the ray which proceeds from the lowest point of the floating T mark through the first principal point of the objective intersects the plate in the corresponding camera at a point which is identical with the point where a ray of light proceeding along the axis of the guide rod would fall on the same plate set up in a similar camera with the first principal point of its objective at the centre of the universal joint on the z-carriage, and its optical axis either normal, in the y direction, or corresponding to the tilt or convergence to which the Autograph has been set.

It remains to be seen how the two separate optical systems are used in combination, to examine a pair of plates taken at opposite ends of a measured base.

When the base is normal to the horizontal projections of the camera axes, the length of the base (reduced to the scale of the proposed map) is divided by 2, and one half set outwards on each base slide. At the same time the height of the L. station above the R., similarly reduced to scale, is set on the vertical slide of the R.H. joint.

When the base is oblique we proceed thus (Fig. 7):

Let O_1, O_2 be the zero points of the base slides in the normal position, and O_1R, O_2L the half lengths $\frac{b}{2}$ of the base supposed set off at the

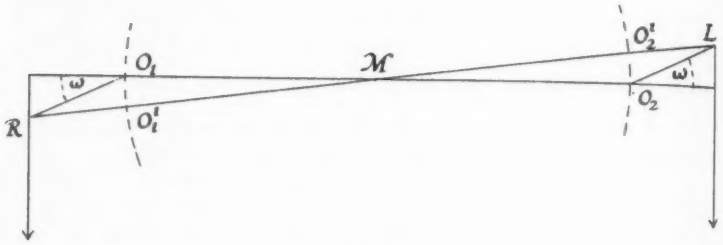


Fig. 7

obliquity ω. We have to bring the universal joints to R and L, by rotating the z-carriage about the vertical through M, the middle point of O_1O_2.

It is easy to show that if β is this angle of rotation,

$$\tan\beta = \frac{b\sin\omega}{b\cos\omega - O_1O_2}$$

and $$O_1'R = O_2'L = \tfrac{1}{2}b\sin\omega\operatorname{cosec}\beta - O_1M$$

Hence we rotate the z-carriage through the angle β, and set the base slides to the lengths of the modified half bases $O_1'R$ or $O_2'L$.

It should be noted that β is usually much less than ω, and that a relatively small rotation is sufficient to allow for a considerable obliquity. Too great an obliquity of the axes is however inconvenient in practice, particularly for close ranges, for the difference in size of features renders stereoscopic fusion uncomfortable or impossible, besides curtailing the effective ratio of Base to Range.

8. Suppose now a pair of plates adjusted in the Autograph cameras; the base slides set as above for the length and obliquity of the base and the relative height of the stations; the tilting block set for the elevation of the camera axes, if any; and the necessary adjustments of the camera prisms made for relative inclination or convergence.

In the binocular telescope the marks of the respective oculars will fuse into one, and appear floating in space. By turning the hand wheels and the foot wheel the floating mark can be made to travel about in the apparently three-dimensional field until it is brought into apparent contact with any point of the landscape seen in stereoscopic relief. The guide rods and slides of the Autograph constitute themselves a scale model of the rays, the base, and the relative co-ordinates of base and object; or, more strictly speaking, it is a scale model in which a large central block of space must be considered annulled. And it should be

noted that this does not depend upon any theory of stereoscopic vision. If A and B are the plate images of the object O, the movements of the Autograph have projected A and B upon the fixed T marks in the foci of the two oculars. The guide rods and slides then reproduce geometrically the circumstances in which the images A and B were photographed, and thus allow us to plot the position of the object with reference to the base, and to determine its relative height. Why the surrounding pictures should fuse themselves into the appearance of a solid model, with the floating mark suspended upon the object, is a physiological question which affects the geometry only by the fact that the appreciation of stereoscopic relief undoubtedly makes it possible to set much more accurately, as well as very much more rapidly, and especially to identify and plot every desired point of the visible terrain, instead of only such conspicuous points as may be identified with more or less certainty on a pair of photographs examined separately.

9. We have now to speak of the actual drawing apparatus. It is evident from paragraphs 7 and 8 that the motion of any fixed point on the y-carriage traces out the planimetry of the terrain. It is necessary therefore only to make the pencil point move as if rigidly attached to the y-carriage. This is effected by transmission through cardan shafts from the ends of the two leading screws in the front of the pillar-head to two similar screws in the front of the drawing-table, one of which drives the pencil carriage in the x co-ordinate, and the other by bevel gear to a similar screw at right angles, drives the carriage in the y co-ordinate. It should be noted that the pencil is driven direct from the hand wheels and not through any complicated linkages, as in some other machines.

If the heights of the base stations are known, the guide rod to the R.H. camera is set horizontal by a striding level, and the height drum, selected for the correct scale and gear, set to the R.H. station height. It should then read the heights of the control points when the mark is set upon them, correction being made for curvature and refraction from a graph computed with the adopted coefficient of refraction (see Appendix). If the height of the base is not known, the height drum is set from one of the control points and verified by the others.

Spot heights in any part of the field are thenceforward determined automatically with the plotting; or if the foot wheel is rotated until the height drum reads the height of any desired contour, and afterwards left untouched, the contour is plotted by moving the mark in apparent contact with the ground by x and y movements only.

There is a second zero pole for the centre of the base and an extension of the plotting board at the base end. By a simple change of gearing the scale of plotting can be reduced in the ratio 2 to 1 or 3 to 1 or increased in the ratio 1 to 2·5, the base settings being modified inversely. The change of gearing does not effect the adjustment of the negatives and is rapidly effected. It is useful in extending the range of plotting beyond

the normal limits for the ratio 1 : 1. For instance, with this last ratio it is impossible to plot within 75 mm. of the base owing to interference between the moving parts. But if the scale of setting on the machine is increased in the ratio 3 : 1 and that of the drawing decreased in 1 : 3, it becomes possible to plot within 25 mm. of the base. And by the increase of gearing to 1 : 2·5 and the employment of the alternative zero pole, the range can be increased to 1 metre.

It will often be necessary, particularly in small-scale topographic work, to plot successively with all the gearings, after commencing with that most suitable for the control points.

10. Suppose now (in the folding plate) that our base is 900 m. with obliquity $\omega = 28°$ to the plate normals, which are parallel and horizontal. The L.H. station is higher than the R.H. by $h = 330$ m.; and a point P distant about 3900 m. is $\Delta H = 570$ m. below the R.H. station. The R.H. station is 1700 m. above sea.

We intend to plot on the scale 1/10,000. And our diagram is on 1/4 the scale of the Autograph. Hence in our plate all parts of the plates and the machine are represented on the scale 1/4, and all distances in the field on the scale 1/40,000. [Note: By an accident the plate is not quite correct in scale: it is 1/3·7 of the Autograph instead of 1/4.]

The f.l. of the camera is $f = 165$ mm. The dimensions of the plates are 150 × 100 mm. The distance between the zeros O_1, O_2 of the base slides, and between the first principal points K_1, K_2 of the Autograph camera axes is 200 mm.

By elementary constructions in plan and section of the field (see Plate) we easily derive the co-ordinates of the images of P on the two plates at P_1 and P_2.

The setting of the oblique base is as in § 8.

The L.S. plate is adjusted in the R.H. camera and viewed with the L. telescope.

The R.S. plate is adjusted in the L.H. camera and viewed with the R. telescope.

The carriages are moved by the three hand wheels until the floating mark is set on the stereoscopically fused image of P. We then have RK_1, MP_0, and LK_2 of the Autograph plan equal and parallel to RP MP, and LP of the field plan.

The guide rods being depressed β_1 and β_2, the centres of the plates are at distances $f \tan \beta_1$ and $f \tan \beta_2$ from the points where the verticals through K_1 and K_2 cut them. They take the positions shown in the drawing, in which however no attempt has been made to foreshorten the plates by the factors $\cos \beta_1$, $\cos \beta_2$ to represent the exact horizontal plan.

P_0 is the origin of co-ordinates, and the co-ordinates of M (middle point of base) in the Autograph are x, y. The co-ordinates of the pencil with respect to the zero of the drawing-board are the same x, y: if there-

fore the plotted position of the centre of the base is brought to the zero, the pencil will draw P in its correct place on the plan.

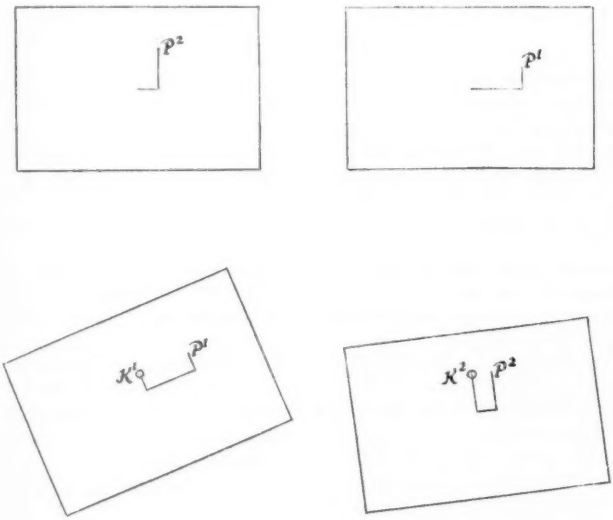
And if the height drum has been set to 1700 m. when the guide rod through R is horizontal, it will read 1700 − 570 = 1130 on P (neglecting curvature and refraction).

11. Suppose now that at both stations the camera is depressed $6^g = 5{\cdot}4°$ and that at the R.H. station the camera is turned inwards 10°, so that the obliquity of the base to the plate is only 28° − 10° = 18°.

The tilt carriage is turned 6^g round the tilt axis in the direction which depresses the line of sight of the binocular telescope 6^g.

The 45° prism outside the objective of the R.H. telescope is turned $\frac{1}{2}10° = 5°$ in the counterclockwise direction, and the horizontal cam plate on the L.H. camera 10° in the same direction.

The guide rods remain in the same positions on the Autograph plan, but their inclinations to the plane *xy* will be changed by 6^g approximately when the floating mark is set on the object again: not by exactly 6^g because the angles α_1, α_2 are changed a little when measured in the sight plane depressed by 6^g, and consequently when β_1 and β_2 are reconstructed they differ from the old values by not quite 6^g. Also α_1, entering into the construction of the co-ordinates, is diminished 10° by the convergence.



Without constructing the plates entirely afresh we can see that the positions of P_1 and P_2 on the plates, and their positions in the autograph cameras with reference to the verticals through K_1 and K_2 will be nearly as above.

In a similar way one may deal with an individual depression of the camera at the left station.

Drawings on a scale double the natural, instead of one-quarter, would be necessary for accurate construction of these cases: but a little reflection will probably show, without this trouble, that the geometry of the Autograph gives the correct solution in all cases.

12. The machine as above described can deal with plates whose axes are inclined downwards to a limiting angle of about 40°. By an ingenious interchange of certain of the y and z motions it can also deal with pairs of air-photographs inclined to about 40° from the vertical, though I did not gather that it has as yet been put to such use. At present it cannot deal with plates within a few degrees of 45° to the horizontal, the difficulty being that at this extreme angle the guide rods will not slide freely in their sleeves. By a beautiful demonstration with a sensitive level Mr. Wild showed us how near 45° the rods seized and slightly bent the whole machine. There is therefore a gap of about 10° between inclinations 40° and 50° in which the machine will not at present operate, and to this small extent it is not universal. We may leave this with confidence to some future inspiration of the inventor who discovered that the projection error could be cured by a rotation and saw his way to mechanize the formula by giving it an unpromising shape.

APPENDIX

The theory of the "false point," and of the "projection error" which the cams correct, is easily deduced by spherical trigonometry. The circle in the figure is the section of the sphere by the horizontal plane. The axis of a telescope is directed along HO to the reflecting prism at O. In the zero position the normal to the reflecting surface cuts the sphere in N_0 and a central ray along the axis of the telescope is reflected to Z vertically above O.

When the guide rod turns the prism through an angle α, the normal cuts the sphere at N. Join HN and produce it to P′ making NP′ = HN. Then by the equality of the triangles NHK, NZP′ we have NZP′ a right angle. Hence by rotation of the camera and prism through α in a horizontal plane the line of sight sweeps along ZL at right angles to ZK containing N, through the same angle α.

Now suppose the camera tilted on its tilt axis through an angle β, so that its axis points to C. Draw P′M′ perpendicular to CL. The gnomonic projections of P′Z, P′M′ upon the tangent plane at C are p_2, q_2 the co-ordinates of the false point.

$$p_2 = \tan \mathrm{CMM'} = \cot \mathrm{MM'L} = \tan \alpha \sec \beta$$

$$q_2 = \tan \beta$$

and

$$\cos \mathrm{CP'} = \cos \alpha \cos \beta$$

But if P corresponds to the true point, its perpendiculars on CK, CL are α and β, and

$$\cos \mathrm{CP} = \cos \alpha \cos \beta$$

Hence P and P′ are equidistant from C.

$$\tan \mathrm{P'CM'} = \cot \alpha \sin \beta$$

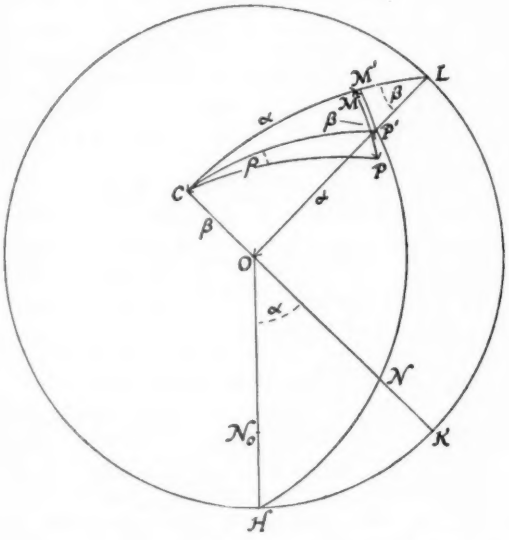
$$\tan \mathrm{PCM}' = \tan \beta \operatorname{cosec} \alpha$$

whence
$$\tan \mathrm{PCP}' = \frac{\tan \beta \operatorname{cosec} \alpha - \cot \alpha \sin \beta}{1 + \tan \beta \operatorname{cosec} \alpha \cot \alpha \sin \beta}$$

or
$$\tan \rho = \frac{\sin \alpha \sin \beta}{\cos \alpha + \cos \beta}$$

This is the formula for the rotation to bring P′ to P. By squaring we easily obtain

$$\tan^2 \rho = \frac{\sin \alpha \sin \beta \tan \alpha \tan \beta}{\dfrac{\cos \alpha}{\cos \beta} + \dfrac{\cos \beta}{\cos \alpha} + 2}$$



and the denominator is readily shown to be equal to 4 if terms of the order $\sin^4 \frac{1}{2}\alpha$ are neglected.

Hence $2 \tan \rho = (\sin \alpha \tan \alpha)\frac{1}{2}(\sin \beta \tan \beta)\frac{1}{2}$. But we have yet to learn how the cams are fashioned to produce ρ mechanically from this strange expression.

Tables for the combined effect of refraction and curvature of the Earth are given by Jordan, and by De Graaff Hunter in the recent Survey of India Auxiliary Tables, Part III. It appears that Jordan's constant k is twice Hunter's k, and that, in the High Himalaya, Hunter would take $k = 0{\cdot}05$. On this supposition the refraction component of Jordan's table (computed for $k = 0{\cdot}13$) was reduced to 10/13 of its tabulated value and added to the curvature component. The corrections derived from the deduced table gave very consistent results in the Shaksgam measures. Our hasty improvisation worked well; but the whole question of this correction at extreme ranges needs further consideration.

FEATURES OF BRITISH HONDURAS

Leslie H. Ower, D.I.C., F.G.S., lately Government Geologist

Map following p. 416.

EVEN though it was 1859 before the mountainous district was added to British Honduras, it is remarkable that it should have remained so little known. The first attempt to cross the Maya Mountains was made by H. Fowler and party, who left Cayo on 27 December 1878 and reached the fork of Rio Trio on 14 January 1879. Bad weather prevented good observations, and their track ran more to the north-eastward than they estimated, which accounts for much of the erroneous information still included on the official map. It is reported that Fowler previously made an unsuccessful attempt to reach the Cockscomb Peak from Pocton, but no records are available.

The next records of exploration in British Honduras consist of notes and unpublished maps made by G. H. Wilson on his river surveys in 1886. I have checked some of his work and found both the surveys and geology very reliable. Unfortunately, Mr. Wilson died before he was able to piece his work together. Mr. Gordon Allen's party visited the Cockscomb in 1888 from Sittee *viâ* South Stann Creek, and produced a good sketch-map of the route. Dr. Carl Sapper made the following trips in British Honduras : April 1891, Punta Gorda to San Louis ; February 1894, Peten—Cayo—Belize—Corozal—La Boca ; February–April 1896, Belize—Orange Walk—Rio Hondo—Cayo—Cockscomb—Deep River—Sarstoon. The report of his geological investigations was published in Belize, but unfortunately his map of British Honduras was never published, and does not show the geology. That information was however incorporated in 'Gebergsbau und Boden des Nordlichen Mittel-Amerika' (1899), the standard work on Central American geology, but only parts have been translated from the German. Sapper got the main features of British Honduras geology, but his classifications are difficult to understand, and the outside information he included was poor.

In 1898 Monohan opened up a trail from Middlesex to the mouth of Roaring Creek to connect Stann Creek with Cayo, but it was little used. A portion was reopened in 1921 and a branch cut to the Bald Hills. My survey from Guatemala to Stann Creek follows this line. The railway surveyors in 1892 ran a trial survey from Belize up the Sibun River to near its source, and in 1896 a branch was surveyed to Cayo. Recently exhaustive reports on both the agricultural and forestry potentialities of British Honduras have been issued, but the coloured maps included have no reference to either soils or vegetation.

Surveys.

The triangulation of the colony has just been commenced. A base line has been laid out between the Sibun River and Northern Lagoon. To take advantage of the few transport facilities the colony possesses, it is proposed to progress westward to Cayo and locate the frontier mark at Garbutt's Falls as soon as possible. The immediate object of the triangulation is to enable the Guatemala Boundary between the Belize and Sarstoon rivers to be cut. In the meanwhile it has been possible to compile a reasonably accurate map of British Honduras, as the Surveyor-General has a large number of land survey plans and the services of a topographical draughtsman from the British Ordnance Survey were placed at my disposal. Almost the whole of the northern area is privately owned, and the few surveys available for this locality are seldom complete. The Mexican Government has a series of survey stations down the Rio Hondo, and a survey to connect these with Belize is almost finished. Private lands on the Sittee River make a gap between the Goverment surveys originating from Belize on the north and from the Sarstoon on the south.

I have made time and compass traverses on all the rivers and traverses by cyclometer, sound, and compass among the mountains. A plane-table was used during the main N. and S. traverse of the mountains, but the only locality where it was really useful was the area of 120 square miles embracing the Bald Hills and Mountain Pine Ridge. On the cyclometer surveys aneroid readings were taken about every 10 chains.

By using eight strikers on a bicycle wheel, a cyclometer may be made to read chains direct. This method of cyclometer surveys, which was originally developed by myself in Australia, is remarkably effective. Owing to the drift of the sound, it is advisable to make a closure for traverses of over 10 miles. The two main traverses in the rough mountain country both closed within 8 per cent. for length and 10° for direction. The mule road in Guatemala linking up Benque Viejo and the Punta Gorda–San Louis trail was inspected but not measured. All Guatemala locations are taken from the latest official map of that Republic which, although founded on only a few surveys, is reasonably correct. There is now enough information to enable contours to be sketched for the geological map.

Physical Features.

The following terms in general local use are apt to cause confusion :

Ridge : Zone or belt of vegetation ; does not imply elevation.

Pine Ridge : Area dotted with pine, on poor soil usually close to sea-level.

Cahoune Ridge : Named after the cahoune palm, which is a distinctive feature in fertile areas. It ranges from sea-level to an altitude of about 1800 feet.

Broken Ridge : The outer edge of cahoune ridge.

Cay : Island ; not necessarily marine, but applied to islets in streams and even to clumps of vegetation.

Sandy Bay : Dry beds of shingle or sand in streams.

Falls : Applied also to runs or rapids.

Three thousand square miles (36 per cent. of total area) are below 500 feet ; 4700 square miles (57 per cent.) exceed 1000 feet in elevation. The highest point is the Cockscomb Peak, estimated at 3800 feet. It is isolated to the east of the main dividing watershed, and is seldom seen except from the Bald Hills and the coastal boats. I believe that only Messrs. G. H. Wilson's and Gordon Allen's parties have visited it, but neither climbed beyond the gaps between the quartzite cliffs of the summit. The other prominent peak in British Honduras is the single saw-toothed Copetilla (over 3000 feet), which is about 5 miles south-west of the Cockscomb. According to G. H. Wilson, who ascended it in 1886, it is a continuation of the contact quartzite of the Cockscomb.

Ridges of over 3000 feet elevation are common farther to the south-west, the highest point being Mount Burdon, 3500 feet, at the source of Rio Chequbul. The most southern of these high ridges is the Quartz Ridge, 3200 feet. It takes its name from a long large E. and W. quartz vein which forms the summit. On the north end of the Maya Mountains is the long E. and W. ridge of the Bald Hills, the highest point, Baldy Beacon, 3200 feet, being made still more conspicuous by the cairn erected on its summit in 1785.

The whole of the mountain area is really a peneplain at an elevation of 2500 to 3000 feet. The north-western portion is capped by limestone, which never exceeds 2500 feet. On the north-eastern edge of this limestone is the Mountain Pine Ridge, which extends into the Bald Hills. The cause of this isolated open pine area is not at first apparent. Except for the Bald Hills the area is almost entirely granite, but the other granitic areas in the colony are heavily vegetated. The eastern end of the Bald Hills is siliceous, and large veins of quartz and quartzite are prominent features south-westward to the Belize River. At the extreme north-west of the Mountain Pine Ridge young grit beds mask the junction of the slate and limestone. The veins just mentioned evidently were the channels through which warm siliceous water rose and on cooling deposited a sand capping attractive to pines. Farther to the south-west there are odd pines, increasing in number until the Pocton Pine Ridge is reached. Near Punta Gorda and Monkey River are isolated limestone hills, and others occur near Manatee. They reach elevations of several hundred feet, and are evidently superior weathering knobs that remained as islands before the sea retreated from the coastal plain.

Weathering.

The Upper Carboniferous rocks, which are the oldest in the colony, consist of slates, sandstones, quartzites, schists, blue limestone and

intruded granites and porphyrys. The strike is usually slightly south of west. The contact of the granite with the slates may produce weakness, but usually a narrow indurated zone. In the former case the streams seek the junction, and in the latter case a ridge is formed. The granite itself usually offers poor resistance to weathering agents. No bands amongst the palæozoic sedimentary rocks are exceptionally weather resisting, so the mountain topography seldom exhibits outstanding features.

The massive limestone rests directly on the upturned edges of the slates, etc., and the whole of the Mesozoic period is unrepresented. To the north-west of the Quartz Ridge the surface of the limestone, although at 2500 feet altitude, is quite level, and is one of the few limestone areas entirely devoid of mahogany. Elsewhere the limestone surface is very irregular as the drainage is almost entirely underground. Deep sinkholes resembling craters are common. This Rio Dulco limestone being usually a hard crystalline variety stands exposure to the atmosphere well, as instanced by the Stann Creek Railway Quarry skerries (now 11 miles from the coast), where the old marine caves are apparently in the same condition as when the sea surrounded them. Cliff faces are prominent features in the high limestone country. Where decomposing vegetation collects the limestone dissolves rapidly, being almost pure carbonate of lime.

Weathering into conical peaks is a feature of the lower-level limestone. The conical hills of the Pocton Pine Ridge usually stand about 250 feet above the plain, but the limestone is sandy and the scenery distinctive.

The isolated hills of the Punta Gorda district are associated with the faulting of that area, and the gaps between them are usually the crumpled Toledo shales. To the south of the Belize River limestone caves are common. The best known are those of the Manatee, and in the same locality the Light and Dark Caves on Indian Creek. As the country is opened up more caves will doubtless be located. The chalky marls are usually confined to the low country, the township of Orange Walk being built above a cliff of this material.

The Toledo beds are mainly thin-bedded shales and sandstone, so are easily attacked by the weather, especially as they occur in the area of heavy rainfall (Punta Gorda 145 inches per annum). They contain lenticular beds of limestone, which, having better weather-resisting properties, will often be found on the crests of low hills. In British Honduras the Toledo series being at low altitudes and away from the coastal plain are dissected into rugged low hills. They form the most fertile soil in the colony, and here are situated the Maya villages of the south. Close to Punta Gorda some American families settled after the Civil War and founded the Toledo Settlement, which is still prosperous. Wooded limestone hills of from 200 to 600 feet elevation stand out from the plain and make it perhaps the most picturesque locality of British

Honduras. A motor road connects the Toledo Settlement with Punta Gorda, but farther inland there is only the bush track that follows the Toledo beds all the way and joins the main trail at San Louis in Peten. Mules can be taken over this trail in the dry season, but usually everything is carried on the backs of men.

The Streams.

Almost the whole of the drainage of British Honduras enters the Caribbean Sea. The Rio Hondo and the New River are parallel streams about 10 miles apart and enter Chetumal Bay at the extreme north of the colony. They are both tidal for a considerable distance up, and are navigable for small coastal boats for a distance of about 50 miles in a direct line from their mouths. During the whole of that distance no tributary of any importance enters. Both seem to follow along lines of dislocation, the low or eastern side being swampy and the western side exposing calcareous rocks which on the New River do not exceed 100 feet, but on the Hondo rapidly rise to about 600 feet above the water's edge and follow close to it until the easterly bend commences. Even Albion Island is swampy to the west and exposes limestone on the east. The sources of both rivers are in the shallow lagoons amongst the limestone hills.

The Belize River is the main drainage channel of the colony, but it really only connects up the various watercourses trending northwards from the mountains. The Sibun River can geologically be considered a Belize River tributary.

Lines of dislocation also affect these rivers when in the younger rocks. In the Belize River, limestone commences to outcrop at Boom and continues up to the main fork near Cayo with the following exceptions: Big Falls to Cocquericot, 5 miles direct; Beaver Dam to Meditation, 3 miles; and Rockdondo to Banana Bank, 3 miles. It is suspected that these long stretches of alluvial occur where the river follows the north-western or lower side of a fault-line. The main mouth is at Haulover, but owing to the shallow water outside and at the bar itself, river traffic takes the Belize town branch. The harbour is shallow and is estimated to be silting up at the rate of 25,000 cubic yards per annum.

The swamps at the back of Belize indicate that the site of the town was once a cay, and that the process of joining it to the mainland is not yet completed.

The next important coastal stream south of the Sibun River is Stann Creek. Its name suggests a corruption of Sand Creek, for the only streams that bring down large quantities of sand are North Stann Creek, South Stann Creek, and Monkey River. The Sittee River that lies midway between the two Stann Creeks drains a slate watershed only. Monkey River is formed by the junction of Swasey Stream and the Bladen Branch, both of which rise on the coast side of the Maya Mountains

and drain a considerable area. They both have their source in acid igneous rocks, and along their banks up to the limit of canoe navigation bananas are grown on a small scale. At present boats pick up more bananas from Monkey River than any other place in the colony.

The next long stream to the south is the Rio Grande. It takes its rise at the 3000-feet Quartz Ridge, but both branches soon disappear beneath the limestone and drop about 800 feet in 4 miles. The main branch at its source is filled with large quartz boulders which serve to identify the stream as it issues from the " resumadero " near the end of the coastal plain. The Columbia Branch does not actually rise in the Quartz Ridge, so that it contains only an odd pebble of quartz. As there are no sandbanks in the river below the junction, the presence of quartz above was unsuspected. Pebbles of non-calcareous rocks in the Toledo streams may remain unnoticed, as calcareous coatings soon accumulate on all objects. On the tributary creeks the calcareous tufa forms small falls which are utilized as crossing-places by the foot trails.

The Rio Moho has the largest drainage area of the Toledo district streams. There is reason to believe that it has its source on the northern side of the Quartz Ridge, but all its tributaries issue from beneath the limestone, quickly form large streams while crossing the Toledo beds and again disappear into tunnels in the limestone. They unite to form the main river at the village of Aquacate at the edge of the coastal plain. The divide between the Caribbean and Gulf of Mexico drainage is between Pusilha and San Louis, about 10 miles across the frontier and about 1300 feet above sea-level. The Rio Sarstoon can be navigated by motor boats almost to the south-west corner of the colony. Except that the spurs from the Sierra de Santa Cruz touch the river at the bar, it has no special interest.

Coastal Features.

Extending the whole length of the coast from the north of Deep River are a string of lagoons separated from the sea by a narrow sand-bank. This is mainly quartz sand, and most of it is derived from a line of siliceous springs not quite dead. The low cliffs of Toledo shales at Baranco and the eroded raised beach at Punta Gorda are the only coastal sections in the colony. Livingstone, however, is built on a marine terrace of well-rounded quartz gravel, the Rio Dulce limestone being exposed at sea-level about 60 feet below. Mangrove extends practically all along the British Honduras coast, either advancing directly into the sea or growing in the swamps behind the sandy beach. This is succeeded by palmetto swamps, fading into sour-grassed land dotted with scraggy pine.

The outstanding feature of the coast is the Barrier Reef. The edge of this reef runs parallel with the shore-line at a distance of from 15 to 22 miles. The principal navigable channel through it is at English Cay,

15 miles south-east of Belize. Between Sapodilla Cays at the southern end of the reef and the Guatemala coast there is a wide stretch of deep water giving access to Belize. Soft limestone and growing coral can be seen on the bottom in the shallow waters north of Belize. On the seaward side of the Barrier Reef there is a sudden drop into deep water. In the calm water inside the reef there are many cays, banks, and submerged pinnacles, most of which are too small to be shown on the map. Shells contribute largely to the formation of these inner cays, but the dry land on the outer cays is almost entirely coral detritus. No elevated coral reefs were noted during the survey. The unsampled rock struck 20 feet below Belize when driving piles for foundations may be coral or soft limestone. The sides of the main entrance channel between Belize and English Cay are evidently limestone, as attempts to drive piles for lighting buoys had to be abandoned.

Of the deep-sea reefs, Glover's, Lighthouse, and Turneffe Reefs belong to British Honduras, while Cozumel and Chinchorro off Yucatan are Mexican. They lie with their long axis representing the continuation of the trend lines of the Barrier Reef, which itself runs parallel with the shore and the hills.

Glover's Reef is 22 miles long and 6 miles wide; Lighthouse Reef, 30 miles by 6 miles; Turneffe Reef, 37 miles by 13 miles.

Both Vaughan and Agassiz consider that the coral reefs of the Caribbean are only a comparatively thin capping and have played an insignificant part in building up the islands and banks of that region. The opinions of these authorities coincide with my own deductions. The base of these reefs that rise suddenly out of as much as 6000 feet of water can at present only be guessed at. A bore put down at the island of Bermuda on a somewhat similar though distant occurrence passed through limestone to 383 feet volcanic material to where boring ceased at 1413 feet. On the Yucatan Peninsula there is no evidence of volcanic eruptions during the whole of the geological periods represented. Almost the whole length of the British Honduras coast runs a line of Recent siliceous springs and quartz veins. The island of Utilla, the most westerly of the Bay Islands, is stated by Powers to consist of a young basalt mound capping a coral reef. There is thus a possibility of the deep-sea reefs having a volcanic base overlain by limestone and capped by coral. Their shape however supports the idea that they are outlyers of the British Honduras rocks.

Some of the few soundings outside the Barrier Reef are as follows: Between Turneffe and English Cay, 800 feet; off south corner of Turneffe, 1900 feet; between south-east corner Turneffe and Lighthouse Reef (south), 2600 feet; between Turneffe and Lighthouse Reef (north), 6000 feet; east of south corner Lighthouse Reef, 9800 to 11,500 feet. There are no soundings round Glover's Reef except one of 1000 feet between it and Lighthouse Reef, but deep water is assumed.

Geology.

The rocks of British Honduras may be considered to consist of a central massif of Upper Carboniferous sedimentary and acid igneous rocks surrounded by thick foraminiferal limestones of about Oligocene age. For the purposes of the preliminary geological survey it has been divided as follows : Coastal alluvial (1100 square miles) ; Toledo shales, etc. (650 square miles) ; Rio Dulce limestone (5070 square miles) ; acid igneous intrusions (370 square miles) ; Upper Carboniferous sedimentaries (1020 square miles).

The alluvial deposits consist mainly of marine accumulations of sandy clay forming the old coastal plain to the eastward of the mountains. It is assumed that limestone underlies them. The surface sand is largely derived from just extinct siliceous springs, the last survival being at Sennis River. In the northern part of the colony the alluvial capping is evidently thin, and no attempt was made to map it. A long line of large flints extends from near the mouth of the Sibun River northwards. Submarine springs appear to have supplied the silica. Flints are also seen between Cayo and Benque Viejo amongst the marls. To the east of Orange Walk quartzite veins were noted in the limestone. They may be present in other northern localities, and be concerned with the formation of pine belts such as adjoins the Rio Hondo. The impurities (15 per cent.) noticed in a typical sample of marls were apparently introduced by the streams that originated as the Maya Mountains slowly rose out of the sea. Fossils from New River have been determined as Miocene, but some of the marls look younger.

Between the mountains of Guatemala and those of British Honduras are a series of thin-bedded strata to which the name Toledo Beds has been given. Associated with these shales and mudstones are lenticular laminated limestones and blue calcareous sandstones that have yielded Miocene fossils. Diatomite occurs in several localities indicating deep-sea conditions, while grains of serpentine suggest a Guatemala origin. Generally speaking, the farther from the sea the fewer are the calcareous bands, the less disturbed the strata, and the more unconsolidated the formation. They may rest conformably on the Rio Dulce limestone. Near the coast the Toledo series are very badly crushed, and there is usually more crumpling than folding ; but in Golden Stream an extensive syncline was noticed, exposing an apparent thickness of 1500 feet. To the south the Toledo beds are down faulted against the Oligocene limestone of the Sierre de Santa Cruz ; to the east they are beneath the sea, while north of Monkey River they disappear beneath the alluvium. The Toledo beds enter Guatemala and may even extend to the south-west corner of Peten. They appear to have been laid down in what was once the western extension of the Bartlett Deep. In south-eastern Peten beds of mudstone and pink and green sandstone occur amongst the limestone. These Santa Toribia beds are evidently from the porphyry of the Maya

Mountains and may be contemporaneous with the Toledo series, but have been mapped as Rio Dulce limestone.

Fossils collected by Powers from the Rio Dulce gorge were referred by Vaughan to the Oligocene Emperado limestone of the Panama Canal. With the exception of the Maya Mountains, limestone is present over the whole area on the downward side of the Guatemala arc of mountain uplift. It evidently at one time covered most of Central America, for massive limestone, of uncertain age, still exists at high elevations amongst the mountains in the Republics. In British Honduras the limestone is mainly foraminiferal, and is usually a recrystallized variety with a white or cream colour. Near the source of the Belize River it is 1000 feet thick, so that on the northern or lower side of the main E. and W. fault it may be much thicker. In the mountains the limestone is generally horizontal. The only place where folding of the limestone has been noted is in the Cayo gorge close to the large fault. The sandstone and mudstone bands in the limestone near Santa Toribia, Peten, show that the pre-limestone drainage was westerly.

Intrusive rocks are confined to the mountain area, and consist of granodiorite in the northern and quartz porphyry in the southern portion, where sills of that material also occur. All the intrusive rocks appear to be of the same age and to have been forced into the still plastic sediments during the great earth-movements at the close of the Carboniferous period.

The Upper Carboniferous sedimentary rocks consist of schists, slates, sandstones, and quartzites, also thin beds of blue crinoidal limestone. Their succession has not been worked out, but the thickness appears to run into many thousands of feet. The strike averages about 250°, and usually conforms to the nearest igneous intrusion. Between the head-waters of the Rios Trio and Chequbul the slates dip less than 10°, but elsewhere the average dip is about 65°.

Tectonics.

At the racecourse at Guatemala City there is a cement model (scale, horizontal 1/10,000; vertical 1/2000) of that Republic, and British Honduras is included. Two dissimilar mountain systems are apparent: the Pacific Cordillera and the Caribbean Cordillera. The first is now represented as a belt of high plateaux above which the young volcanoes protrude to elevations of 10,000 to 13,000 feet, forming the backbone of Guatemala. The depression to the west is indicated by the narrow coastal plain, the uniform great depths of the Pacific Ocean relatively close to the shore, and the submarine contours parallel to the coast-line. The Caribbean Cordillera consists of east and west ranges stretching from the Atlantic almost to the Pacific slope. British Honduras, Peten, and Yucatan are in a depression bounded by the arc extending from Puerto Barrios through the valley of the Rio Usumacinta. The small

and isolated situation of British Honduras has been unfavourable for the formation of long east and west valleys. The northern portion of the Republic of Honduras has long east and west ranges and similar features to the mountains of Guatemala.

Suess considered that the Antillian continent embraced the whole of the West Indies, the north of South America, and Central America as far north as the Isthmus of Tehuantepec. He originally divided it into three zones : an Inner Zone, comprising the volcanic islands of the Lesser Antilles ; an Intermediate Zone, covering the Greater Antilles, Central America, and the north coast of South America ; and an Outer Zone, Yucatan, Florida, and the great banks to the eastward. He afterwards modified his opinions and was inclined to accept Sapper's view that the Lesser Antilles were built up from volcanic material. The author's observations and studies of the Caribbean do not favour the idea of an Antillean continent as propounded by European geologists.

Bailey Willis, in his Index to the Stratigraphy of North America, assumes that the Deeps of the Caribbean and the Gulf of Mexico have been permanent features since Cambrian time. These permanent deeps permeate all his maps of reconstruction. The period during which an Antillean Continent may have existed can be defined, although in Central America or the Antilles it is doubtful whether rocks older than Carboniferous are exposed. These sedimentary marine beds are extensive, but there is no evidence that they extended far into what are now the Pacific and main Atlantic Oceans. They were laid down in the North Equatorial geosyncline. During the great earth-movements at the close of the Carboniferous, these marine sedimentary deposits were crumpled by pressure from the north and south. Granite was forced into the crests of the folds, and the Antillean Continent formed. The Lower Mesozoic plant beds of Southern Mexico, Honduras, and Cuba indicate that continental conditions continued into that period.

The existence of extensive Cretaceous and Early Tertiary marine accumulations amongst the Antilles suggest that the continent was breaking up and portions subsiding in Jurassic times. Between Jurassic and Miocene the general tendency has been subsidence associated with faulting without much folding. A wide marine connection between the Pacific and Atlantic Ocean was at times produced. During the great earth-movements at the close of the Miocene, the present outline of the Caribbean Sea and Central America commenced to develop. The frequent earthquakes, especially of the Pacific Coast and the Bartlett Trough, indicate that this region is still far from stable.

The geological history of British Honduras and the parts adjacent to it may be stated as follows : There is nothing to indicate events prior to the Carboniferous. During Carboniferous times it formed a portion of a geosyncline and was covered with sea of only moderate depth. At the end of the Carboniferous it was compressed into east-west ridges, elevated,

and granitic rocks pushed into the crests of the folds. It remained a land mass until Early Tertiary times, and its final subsidence must have been rapid, for the Oligocene deep-sea limestone rests directly on the granite and upturned edges of the slates. Subsidence continued, and what is now the Maya Mountain area was planed off level by the sea. This could not have descended much below sea-level, for even now the top of the limestone lies over 500 feet below the adjoining slate ridges. During the great Miocene earth-movements the Maya Mountain block again emerged, dragging up some of the limestone with it. About that time the large north-south fault defined the British Honduras coast, and the Toledo beds accumulated. The sea lapped the eastern side of the mountain block until almost Recent time, when the coastal plain developed. At the present time, although no earth-movement has been recorded and earthquake shocks are few, the tendency is for the mainland to rise and the cays and reefs to subside.

Vegetation and Soil.

Although a well-equipped Forestry Department has been in existence some years there is no sketch-map of either the soil or vegetation. In the meanwhile the following rough subdivisions may serve :

Pine Belts : Areas of poor sour lands with coarse grass and dotted with pine. These follow the coastal plain northward from Deep River to near the source of the Rio Hondo. Savanna land without pine is uncommon in British Honduras, but it exists to the south-east of Flores Peten. The Mountain Pine Ridge of 120 square miles has already been mentioned. The isolated pine belts that occur on Roaring Creek and on the north side of the Belize River may be included in the area from which the sea has retreated comparatively recently. Pine exists on the edge of the hills in patches between Swasey Stream and Manatee. They contain much undergrowth which is unfavourable for the growth of pine seedlings. At Swasey Stopper pine logs are seen, but no standing pines. The origin of these old coastal cliff pine belts has not been studied, but perhaps the siliceous springs that provided most of the sand for the low-level pine belts, at one time developed along a parallel line farther inland. There are odd pines on some of the quartzite and porphyry near the source of the Rio Chequbul and trending towards Dolores Peten. Farther south where the main trail crosses the Rio Machiquila the large Pocton Pine Ridge commences. The denser vegetation, usually with the assistance of wild cane, appears to be everywhere encroaching on the pine areas.

Cahoune Belts : This palm is usually characteristic of fertile lands. These form only a small proportion of British Honduras, and may be subdivided into stream alluvial, marls, Toledo beds, granitic basins and accumulations of soil on limestone.

Stream alluvial : The mountain valleys are narrow and collect little

alluvial. Where they meander through the coastal plain they have fertilized a strip seldom more than a mile wide. The hill detritus often enriches the land at the end of the coastal plain.

The Marls are confined to the northern district, but at Cayo they have been elevated to about 600 feet by the main east and west fault. During the geological survey there was no opportunity to define their area. They are cultivated by the Mayas and embrace the Corozal sugar estates. Logwood is confined to the calcareous swamps.

On the Toledo shales, etc., are the sugar estates of the Punta Gorda district and the Maya Indian villages farther inland. This is perhaps the most fertile land in the colony.

Granite basins: Mullins River, North Stann Creek, South Stann Creek, and Swasey Stream have each worn out fertile basins in the granite before entering the coastal plain by slate gorges. With the exception of North Stann Creek none of these are at present cultivated owing to lack of transport facilities.

The limestone has usually been cultivated by the Mayas wherever enough soil could be retained. Ruins of agricultural terraces are common amongst the mountain limestone between the Belize and Chequbul Rivers. The high and level limestone country around the Quartz Ridge has evidently never been cultivated, and is the only large limestone area without mahogany.

The slate country is rugged and well vegetated, but as it is devoid of both mahogany and sapodilla, has remained unexplored until traversed for geological information. The same applies to most of the porphyry. Both these types of formations gave apparently no commercial value. The undergrowth of the British Honduras virgin bush is seldom thick, and none of the trees grow very tall, the main growth being high palms and valueless sticks of small diameter.

Maya Civilization.

Without raising difficult questions of Maya archæology here, the following notes upon the distribution of that culture may be useful. The Maya tribes were spread over a wide area, but the civilization appears to have been confined to the Mexican provinces of Tabasco, Chiapaz, Campeche, and Yucatan, British Honduras, Northern Guatemala, and the fertile valleys of the Rio Matagua and streams of North-West Honduras. Maya speech extended farther. It is noteworthy that with the exception of Copan, Quirigua and Quen Santo, the Maya civilization was confined to limestone country of only moderate elevation. The maize-producing power of this type of country possibly explains why it flourished there. Attention has been lately drawn to the Maya site of Lubaantun (see *Geogr. Journ.*, 68, p. 506). A large settlement would be expected at that spot, as it is the head of canoe navigation of the Rio Grande, and on the most fertile land of British Honduras.

Another important site is at Quirigua, in what is still one of the most fertile parts of Guatemala. It cannot be, therefore, exhaustion of the soil or of water supplies that caused its abandonment. This is more likely to be attributable to the outbreak of internecine strife among the various clans and the final and crushing blow of the Spanish invasion. On the limestone country in the north-west corner of the Maya Mountains of British Honduras, now entirely uninhabited, agricultural terraces have been found wherever it was possible to retain a few yards of soil. On the level limestone, of 2500 feet altitude, at the south-west corner of that area, there is no sign of old cultivation, and mahogany is absent. Agricultural terraces are seen on the low limestone area between the Belize and Sibun Rivers, so probably extend into Peten although not recorded. Terrace cultivation is not practised by the present Mayas. At the limits of canoe navigation of the streams, mounds and ruins of old buildings are to be found, evidently forming the outposts of the inland settlements. At Little Rocky Point, near Belize, a limestone outcrop was originally worked for flints, the rejected blocks being afterwards piled up to make a look-out mound about 60 feet high. A number of other look-out mounds are reported to exist in the northern district.

Economic Prospects.

The colony's industries consist in extracting mahogany and bleeding "chicle," used for chewing-gum. Small quantities of logwood, coconuts, bananas, and tortoise-shell are also exported. Logwood is confined to the northern portion of the colony, the swamps amongst the low limestone being favourable for its growth. Mahogany appears to be confined to the calcareous and, to a lesser extent, granitic soils. The trees are scattered, and an average of one to the acre is considered good. Mahogany is seldom found in the virgin forest, but belongs to the secondary vegetation. I have scarcely ever seen it except on lands that had been cultivated during the old Maya civilization. The logs from British Honduras and adjoining Mexican territory command the highest price in the world's market. Mahogany is not as plentiful or as widespread as was formerly supposed, and the commercial success of afforestation has yet to be demonstrated. The tree does not grow rapidly; it is generally assumed that it requires from fifty to eighty years to become commercially valuable.

The secondary woods, such as cedar, rosewood, nargusta, yemeri, and santa maria, are not profuse, and would only pay if worked in conjunction with mahogany. With other countries developing their resources of ornamental woods, the premier position of mahogany cannot be guaranteed.

Although very little sapodilla gum (chicle) is now bled in British Honduras, much is produced in Peten and Yucatan. The sapodilla

tree grows almost exclusively on calcareous soils, but it is only the marls and limestones of Peten, Yucatan, and Northern British Honduras that provide the variety of sapodilla suitable for the manufacture of chewing-gum. The whole of the trunk, and even the limbs, are bled in one operation, and this can be repeated in about five years. The planting of sapodilla trees in northern British Honduras has been commenced with encouraging results.

The local pitch pine is not a large tree, and is dotted over most of the sour coastal plain. There is one elevated belt of 120 square miles in the north-west of the mountain area. Several American companies have mills on the coastal plain south of the Sittee River, and, though their output is now small, the diminution of world supplies should induce increased attention to these resources.

Agricultural lands are not extensive, and at present supply only a small proportion of the foodstuffs consumed. This may be gradually remedied, and it should also be possible to grow bananas immune from Panama disease and restore that export trade. The Mountain Pine Ridge might be improved into a fair grazing area, and, from other pastures also, sufficient fresh meat for local consumption might be obtained, and possibly even a small export trade developed.

Although the rocks of the mountains are not unfavourable for minerals, they have only yielded very small quantities of tin and gold. As the geological survey has not been carried out very thoroughly, the mineral prospects may yet be found to be more promising. Petroleum is possible in Peten and northern British Honduras, though no see pages are known.

The development of the colony is retarded by lack of transport facilities ; boats and canoes are the usual means. A fleet of specially constructed shallow-draught motor-boats ply on the Belize River to where it emerges from the hills at Cayo. In the dry season it frequently takes three or four days to reach Cayo, and freights rise to £10 per ton. This is the natural outlet of the Guatemala province of Peten, which produces a large proportion of the world's supply of " chicle."

Except through Guatemala, there is no trail connecting Punta Gorda with Belize. As internal transport is practically limited to the rivers, settlements are found at a short distance from the banks, and seldom beyond the limits of canoe navigation. To the south of the Sibun River, this limit rarely exceeds 10 miles in a direct line from the coast. Except at Benque Viejo on the Guatemala frontier, transport animals are practically unprocurable, and the only carriers are the Maya Indians from the villages behind Punta Gorda.

The only railway is 25 miles in length and runs up the Stann Creek valley. It was built to serve the banana plantations at Middlesex, abandoned for some years past through the ravages of Panama disease. The railway is little used at present, but a low gap communicates between the head of Stann Creek and Leura Creek, one of the Sibun tributaries,

so that the extension of the line into the Belize valley and thence into Peten is possible.

THE THAMES DRAINAGE SYSTEM AND THE AGE OF THE STRAIT OF DOVER

L. Dudley Stamp, D.Sc., B.A.

GEOLOGISTS and geographers alike will be grateful to Professor J. W. Gregory for his useful review of the conflicting theories concerning the still unsolved problem ot the age of the Strait of Dover (*Geogr. Journ.*, 70, pp. 52–9). In a subject of such wide interest it is

Fig. 1. *The maximum extension of the Ice-sheets of the Glacial Period*

inevitable that there should be many and varied points of view, and there are, accordingly, one or two aspects which seem to the writer to be worthy of further consideration.

First with regard to the former confluence of the Thames and the Rhine. It is surely of paramount importance to distinguish between conditions as they may have been *prior* to the maximum glaciation of the Great Ice Age and conditions as they may have been immediately *after* the retreat of the ice. Professor Gregory refers to the ancient river which crossed Suffolk and Norfolk in late Pliocene and early glacial times and which has generally been regarded as the estuary of the Rhine. But this is definitely a pre-Glacial phenomenon and the result of conditions established in Pliocene times. On the other hand, the zoological facts which Professor Gregory rightly regards as so significant can be used only as evidence concerning post-Glacial conditions. In particular there is the distribution of the freshwater cod, the Burbot (*Lota lota*), found in those rivers that discharge into the Wash and the Humber, and also in the Rhine, but not in the Thames. The accompanying figure (Fig. 1) shows roughly the maximum extension of the ice-sheets of the Glacial Period. It will be observed that the ice *almost completely covered* the Wash and Humber drainage systems, and it is surely inconceivable that the Burbot—or indeed any other fish at present inhabiting our temperate rivers—persisted in that area during that period. The evidence of the distribution of fishes would therefore seem to show that the Rhine–Humber–Wash systems have been connected *since* the period of maximum glaciation, whereas the Thames has not. Messrs. B. B. Woodward and A. S. Kennard are emphatic that the freshwater molluscan faunas of the Thames and Rhine are so similar that the two rivers must have joined. Since the hardy freshwater molluscs seem to have survived in Southern England during the rigours of the Glacial Period, may not this affinity of the Rhine–Thames faunas be regarded as evidence of a former, pre-Glacial union of the Thames and the Rhine?

Turning now to the age of the Strait of Dover, it would seem that some of the detailed work carried out during the last five years, particularly by Dr. S. W. Wooldridge, has an important bearing on this question. The present writer, in his 'Introduction to Stratigraphy' (1923, p. 300; Figs. 76–77, p. 301), emphasized the importance of the Diestian peneplain on which lie the earliest Pliocene (or, according to some authors, latest Miocene) deposits. The peneplain stretches without a break from Surrey, through Kent, to Northern France and Belgium. The Lenham Beds resting on it in the Folkestone area and those of Les Noires Mottes near Calais lie at such closely comparable heights above sea-level that any gap in the position of the Strait of Dover is impossible to conceive at this period. This is particularly the case when one remembers the close lithological resemblance between the Lenham Beds of Folkestone and those of Calais. Dr. Wooldridge has studied with remarkable care the Diestian Peneplain (*Proc. Geol. Assoc.*, vol. 38, 1927, pp. 49–132, especially Fig. 10); he has been able to trace within very narrow limits the shoreline of the Diestian Sea (see Fig. 2).

Later in the Pliocene period the sea retreated northwards, and in it were deposited the well-known Crag beds of Norfolk and Suffolk. The sea was in retreat northwards, and it seems directly opposed to the evidence to imagine it flowing through a newly formed Strait of Dover which must have been cut out by some unknown agency acting with truly amazing speed between Diestian (Lenhamian) and Coralline Crag times. Professor Gregory's evidence for this early Strait of Dover is summed up in the words (p. 56) " Shortly afterwards, in the early Pliocene, the Strait of Dover must have been submerged, for during the Coralline Crag a warm sea spread over the southern part of the North Sea." The writer has previously favoured the idea that this connection with warm southern waters was by way of the western end of the London Basin

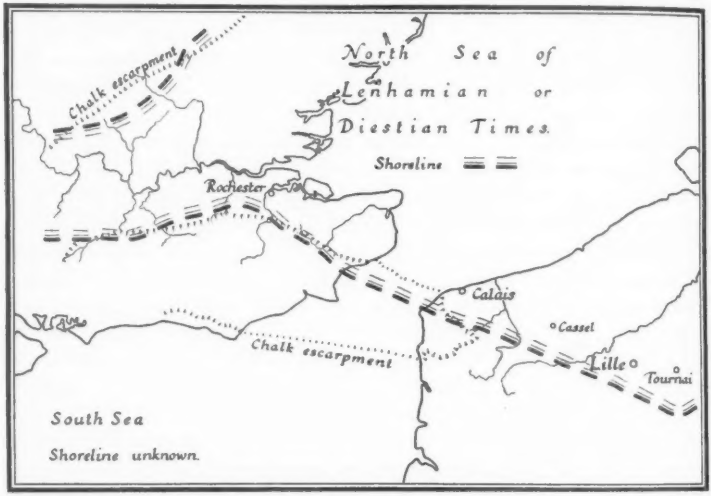


Fig. 2. The geography of earliest Pliocene times. The shoreline of Diestan Sea in England after Wooldridge

(*vide* Fig. 79 of ' An Introduction to Stratigraphy '). This idea is supported by the close comparison possible between the fauna of the Pliocene at St. Erth (Cornwall) and the Coralline Crag ; and also by the remarkable known western extension of the early Pliocene sea in the London Basin (shown in Fig. 2). The writer has no desire to over-emphasize this possible connection, others are possible, but one by the Strait of Dover seems amongst the least likely.

With the sea retreating northwards in later Pliocene times, the normal drainage would be a series of parallel consequent streams flowing northward off the Wealden uplift. There is ample evidence of the existence of many of these streams ; Dr. Wooldridge has collected data to show the position of the Proto-Mole, Proto-Darent, Proto-Medway, and others.

Some of the more important are shown in Fig. 3. One of them is there called the River Lobourg from the fact that its valley must have occupied the "Creux de Lobourg," now in the middle of the Strait of Dover. Its existence has been postulated by Monsieur A. Briquet in his interesting paper "Sur l'Origine du Pas-de-Calais" (*Ann. Soc. géol. Nord*, vol. **46**, 1921, pp. 141–157). The cutting of the Lobourg trench must have been closely comparable to the cutting of the Stour gap, only about 30 miles to the west.

Towards the close of Pliocene times the Proto-Thames must have occupied the centre of the now abandoned Diestian sea bottom, and the consequent streams from the Weald must have formed its tributaries. Of these it is probable that the Lobourg River was one. But at this time

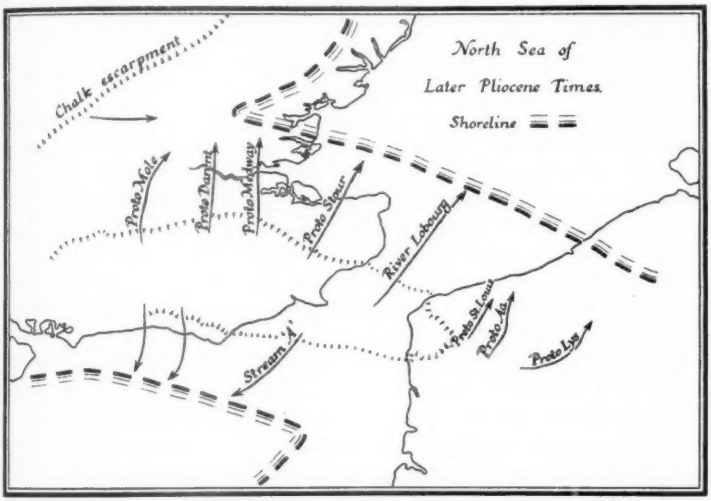


Fig. 3. The geography of later Pliocene times. The shorelines are approximate only

the southern Pliocene Sea probably occupied roughly the position of the English Channel. There is now evidence that the southern Diestian Sea (not to be confused with that referred to above) stretched as far north-east as Beachy Head. Later in the Pliocene consequent streams from the Wealden must have drained into this sea from the north. A hypothetical stream of this nature is marked "A" on Fig. 3.

It is possible to conceive that, towards the close of the Pliocene, the headwaters of the stream "A" captured the headwaters of the Lobourg, at that time a tributary of the Thames. The flow of waters in the Lobourg would be reversed and the Thames led through the Lobourg into the English Channel, and divorced from a previous connection with the Rhine system. This makes possible the curious course of the Thames

suggested by Professor Gregory, and allows for the existence of the Strait of Dover as a deep river channel at the end of the Pliocene.

The similarity between the Quaternary faunas of Southern England and Northern France makes it doubtful whether the deep river valley of the Lobourg was occupied by the sea until well on in Quaternary times. One is tempted to suggest that the " ponding " of waters in the North Sea in front of the advancing ice-sheet was mainly responsible for widening the breach.

There seems no evidence of the existence of a Strait of Dover before the period marked by the famous raised beach and ancient cliff at Sangatte, near Calais. The deposits of the raised beach are covered by deposits with remains of the mammoth (*Elephas primigenius*). Great importance has always been attached to the discovery by Prestwich of tiny pebbles of igneous rocks in the raised beach at Sangatte (not " granite boulders " as suggested by Professor Gregory). Prestwich unfortunately lost the tiny pebbles before he had had an opportunity of studying them, but suggested their possible derivation from the Channel Isles, a suggestion necessitating that the Strait of Dover was open in early glacial times. Actually these igneous pebbles are extremely rare in the Sangatte deposits. The writer has spent many hours in vain searching for them, and so have others. Monsieur G. Dubois was more fortunate, and has recorded one tiny pebble of rose-coloured white mica granite (*Ann. Soc. géol. Nord*, vol. 46, 1921, p. 41). The specimen was insufficient to enable the parent rock to be known. The evidence is not, therefore, conclusive that the Strait of Dover was open even in early glacial times.

Although it has been suggested above that river capture may have allowed the Thames to flow into the English Channel, such a condition is not necessary to the hypothesis that the North Sea invaded and enlarged the valley of a consequent stream, the Lobourg. The main point is that it is difficult to conceive of the existence of the Strait of Dover before Quaternary times.

DISTORTION OF THE LAND IN THE JAPANESE EARTHQUAKE OF 1 SEPTEMBER 1923

Charles Davison, Sc.D., F.G.S.

IN two articles in this *Journal* (63, 1924, pp. 241–243; 65, 1925, pp. 51–54), the remarkable distortion of the bed of Sagami Bay has been described. Much less in amount is the distortion of the land, though in any other earthquake this would have been regarded as considerable.

Immediately after the earthquake, the Land Survey Department of the Japanese Army began the revision of levels in order to determine

the changes of elevation connected with the earthquake. About the same time the Department undertook a new triangulation covering the whole disturbed region. This work is still unfinished, but by the end of 1925 about half the region—the more important half—was done. The very valuable map of this region has recently been published by Major-General H. Omura (*Bulletin of the Earthquake Research Institute*, vol. 1, 1926, pp. 65–68). Its main features are shown on a much reduced scale in the accompanying map. The curves in this show the changes of elevation and depression for every fifth of a metre from a rise of

2 m. to a depression of 1·2 m. The curves of equal elevation are denoted by continuous lines, and those of equal subsidence by dotted lines. The vertical displacements are referred to the Standard Datum at Tokyo, the height of which is assumed to be unaltered.

The chief areas of elevation, it will be seen, lie to the north of Sagami Bay and in the southern half of the Boso peninsula. In the former district, the highest elevation marked is one of 2·01 m. at a point about 2 miles east of Kodu. There is also one of 1·49 m. at a point about 4 miles north of Misaki. Besides these two main areas of uninterrupted elevation, there are two small areas of little consequence to the west and north of Tokyo, and a small area of marked elevation about 13 miles

north of Kodu. In this region the curves of equal elevation are drawn for each half-metre only. At Mount Hemuro the rise is 2·65 m., the highest marked on the map.

Except for these small regions, the area of subsidence is continuous. To the north and west of Mount Hemuro lies the main area of depression. The greatest measured is 1·62 m., in a district about 7 miles north-west of Matuda. As a rule, however, the amount of depression is less than 0·4 m., and along the west shore of Tokyo Bay it is usually much less. Along the east shore of that bay a slight elevation of about 0·1 m. is indicated.

REVIEWS

EUROPE

Picturesque Great Britain : the Architecture and the Landscape.— E. O. Hoppé. With an Introduction by **Charles F. G. Masterman.** London : Ernest Benn, Ltd. 1926. 12 × 9½, pp. xxx. + 304. 304 *Photogravure Illustrations.* 25*s. net.*

As Mr. Masterman points out in his preface, Mr. Hoppé has confined himself for his scenes almost entirely to rural, or "green," England ; but even within this limit he has concentrated upon certain districts, particularly the West Country. Scotland and Ireland are also somewhat arbitrarily treated. However, since the selection could not be comprehensive or satisfying to all, the quality of the plates is the test for such a work, and, when all is considered, they emerge from it well. In some the effect of sunlight has been well caught, though on the whole the best pictures are those in which least striving for effect is displayed. Some of the plates of London are unnecessarily murky. Architectural subjects, from cathedrals to cottages in rural settings, constitute the majority of the plates, and the impression one gains is the variety and wealth of England in this respect. The foreign public, for whom the work is in part designed, might come to picture England as a vast, trimly kept park, with but few inhabitants, for life is absent from most of the pictures.

London's Countryside : the Rural Ways between Oxford and Canterbury, Cambridge and Guildford.— Edric Holmes. London : Robert Scott. [1927.] 7½ × 5, pp. xii. + 344. *Illustrations.* 7*s.* 6*d. net.*

The Bristol Avon.— Ernest Walls. Illustrated by **R. E. J. Bush.** London : Arrowsmith. [1927.] 8½ × 5½, pp. 318. 10*s.* 6*d. net.*

Everyman's Sussex : the Countryside in Varying Moods and Seasons.— Richard Gilbert. London : Robert Scott. 1927. 8½ × 6½, pp. 119. *Illustrations.* 3*s.* 6*d. net.*

Whatever the plight of the English countryside may be, it continues to support an undiminishing number of topographical writers, with varied styles and aims. Mr. Holmes has marked out a fresh province for himself by flinging the bounds of ' London's Countryside ' as wide as possible. The size of this area is rather a handicap than otherwise, for the rural ways tend to be confined to practicable motoring roads, and space prevents more than brief *précis* of town and village histories. The book should serve as a useful companion, especially to those Londoners, if such there be, who have yet to realize the proximity of so much diverse and typical country.

Mr. Walls is more discursive and wanders unhurriedly down from the Cotswolds to Bristol, fitting the incidents of local annals into the more spacious pageant of English history. The valley is linked to the Middle Ages by Malmesbury, to the eighteenth century by Bath, and by Bristol to the modern world. Incidentally the author makes an eloquent plea for the compilation of village histories while there is yet time.

As a complement to such books as the above, Mr. Gilbert's slight sketches depict the works of Nature rather than of man. Though concerned with Sussex scenes they embody the characteristics of English country as a whole. The author has observed for himself and set down in a simple, undistinguished style, glimpses of the procession of the seasons.

A Londoner's Own London.— Charles G. Harper. London: Cecil Palmer, 1927. 9 × 5¾, pp. viii. + 290. *Illustrations.* 10*s.* 6*d. net.*

This is yet another of Mr. Harper's irrepressibly chatty and discursive books on London. This time he takes us for rambles along the Strand, through Covent Garden, Bloomsbury, Pentonville, St. Marylebone, St. John's Wood, down the Mile End Road, to Stepney Church and Poplar. He makes good play with the contrast between the Strand of to-day and of 1838, as recorded in Tallis's 'London Street Views.' Less than a century back the street is unrecognizable. Our guide is replete with information and humour, and his reminiscences are entertaining, the result of the close observation and curiosity of a lifetime. He makes his own illustrations. (On p. 214, St. Pancras Church, *Canaphoræ* should be either Kanephoroi or Canephoroi, in spite of Pliny's Canephoræ.) S. E. W.

Disappearing London.— E. Beresford Chancellor. London: The Studio, Ltd. 1927. 12 × 9½, pp. 10. 12 *Plates.* 5*s. net.*

The twelve etchings here reproduced show London, mostly of the West End, in the process of transformation, though that of Waterloo Bridge is fortunately an exception. As Mr. Chancellor claims in his introduction, apart from artistic excellence (and all are attractive) they will be of value and interest to the future historian of London.

The Balearics and their People.— Frederick Chamberlin. London: John Lane. 1927. 9 × 5¾, pp. viii. + 262. *Maps and Illustrations.* 18*s. net.*

In this book will be found a short account of the history, climate, people, folklore, and flora of Majorca, Minorca, and Iviza, the three largest islands of the little Balearic archipelago off the coast of the Spanish province of Valencia. Their situation between the coasts of Southern France, Eastern Spain, and Northern Africa has made them the scene of many stirring and tragic events from early times. The inhabitants suffered cruelly during the contests between Spain and the Moors, and from the domestic quarrels of Spanish rulers. Their position gave the islands considerable importance in the Middle Ages, and Palma, the capital of Majorca, with Barcelona controlled the shipping of the whole Western Mediterranean. Having lived for some years in Majorca the author is able to give an interesting account of the present condition of the islands. But a strong motive in writing his book is evidently to describe the Prehistoric Monuments, which exist in much greater numbers than is generally supposed. These monuments, found chiefly in Minorca, are of the megalithic order, and have been explored and examined by Mr. Chamberlin with enthusiasm and pertinacity resulting in several discoveries of his own. He is able to show

that the accounts of them that have been generally accepted are not altogether reliable in regard to either their structure or use.

These monuments are of three kinds: (1) *Talayoti*, of which no fewer than 192 have been discovered, and nearly all have been inspected by the author. Only about a hundred of them, however, are in a fair state of preservation. They are round, elliptical, or quadrilateral erections of large unmortared stones, and have often been compared to the round tower-like structures, or *nuraghi*, of Sardinia. They differ however from the nuraghi in never suggesting a tower, but rather a mound, in having no staircase, and, with three exceptions, no internal chamber of any size, whilst the majority have no entrance of any sort. Although unable to say what was their use, Mr. Chamberlin is quite certain about what they were not. He says they were not fortresses, as suggested by Professor Peet, who is regarded as an authority on megalithic monuments; not tombs, dwellings, watch towers, cenotaphs, or temples. In view of these negations it is difficult to suggest any explanation of their use. The only one he seems to favour is that suggested by Sir E. W. Budge, that they were pyramids of a funereal nature, and associated with the second kind of monument, the (2) *Taulas*. These are T-shaped megaliths, always situated on high ground, and near a Talayot. A Taula consists of two large undressed, stones, 5 to 13 feet long, 3 to 8 feet wide, and 1 to 2 feet thick, one upright, the *pie*, and a horizontal one placed across the top, called the *mesa* or *tabla*. Each Taula was apparently surrounded at a distance of about 15 feet by a stone wall, 6 feet high, containing menhirs at regular intervals. These *circulos*, as they have been rather inconsistently called, were horseshoe shaped, with an entrance on the straight side. The author is able to show that Peet is mistaken in saying that the stones are carefully worked, and Guillemand equally so in asserting that they are mortised. He is emphatic in contradicting the opinion of the distinguished French archæologist, M. Cartailhac, who is followed by Peet, that the Taula was the central part of a building. It seems a more feasible explanation that they were altars for sacrifice, or other funereal ceremonies. Fergusson in his celebrated book on Stone Monuments, published more than fifty years ago, remarked that the Taulas are unlike anything we know elsewhere, and no discoveries since made contradict his statement.

The third kind of monument is (3) the *Nau*, so called because it resembles an upturned boat flattened at one end. The best-preserved example, the Nau of Els Tadows, has been long known and was described by Cartailhac in his 'Monuments primitifs des Iles Baléares.' It is an impressive structure built of large flat stones arranged in regular unmortared layers. It is 42 feet long, 14½ feet high at the flat end, which is 18½ feet wide at the base. Inside is a considerable chamber approached by a low narrow entrance passage. The author says Peet is again wrong in his statements regarding the orientation and shape of the façade. He offers no explanation of the use of the Nau, but Professor Peet says they seem to be tombs, as human remains have been found in them. If the author's conclusions are sound, these Balearic monuments afford an interesting example of how by accepting second-hand information even distinguished archæologists may spread misleading views. No excavations or very thorough examination of the Talayoti and Nau seem ever to have been made. When this is done some more definite and reliable conclusions regarding their meaning and use may be possible. Mr. Chamberlin rounds off his account with a week's itinerary during which all the chief Talayoti can be visited. This is illustrated with a large map of Minorca on which their sites are marked. It will be very useful to all visitors to the island who are

interested in antiquities. The book contains numerous photographs of the monuments, and there is also a map of Majorca and Iviza.

E. A. P.

Naples through the Centuries.— Lacy Collison-Morley. With 23 illustrations and a map. London: Methuen. 1925. 9 × 5½, pp. xii. + 227. *Plan and Illustrations.* 10*s.* 6*d. net.*

During the last couple of years, several singularly interesting books have appeared dealing with the political and literary history of Naples. Besides Croce's 'Storia del regno di Napoli' (surely a masterpiece of "affetto al natio loco"), there lie before the reviewer Torraca's 'Aneddoti di storia letteraria napoletana,' Perito's study of the Conspiracy of the Barons, with a critical text of the sonnets of the Count of Policastro, Rodolico's masterly volume on the people of Southern Italy at the beginning of the *Risorgimento*—a valuable supplement to Croce's well-known work on the Neapolitan revolution of 1799. We may account it fortunate in one respect that Naples does not present the same obvious attractions to the average British tourist as do Rome, Florence, and Venice, for the result is that it does not tempt the facile pen of the English literary amateur, from which it is perhaps also in some measure protected by the difficulty of its dialect. Mr. Collison-Morley has the advantage, not only of a long acquaintance with the city, but also of a knowledge of the Neapolitan vernacular and the local literature. He has given us an interesting and useful, well-informed book, with plenty of local colour, an eminently successful attempt "to give some idea of what the Siren city has stood for at different periods during her long life."

Mr. Collison-Morley skilfully guides his readers through the various periods of Neapolitan history from classical and mediæval times to the present day, or, if we prefer to put it so, from the Naples of Virgil and Boccaccio to the Naples of Croce and Salvatore di Giacomo, doing full justice to the more vivid episodes in each epoch and the significance of the existing monuments as landmarks; giving some account, too, of the many illustrious men of letters whom the city and region have produced. But in this connection, should the great name of Antonio Genovesi have been passed over in silence? It is pleasant to find Luigi Tansillo quoted at the outset, for his *Clorinda* is perhaps the poem which best gives us the very spirit of the enchanted bay. But surely it could only have been a momentary confusion with Charileo that induced the statement that the poet was "a Spaniard from Barcelona" (p. 91). Tansillo was born at Venosa, and could therefore boast of being a fellow-townsman of Horace: "Di che posso io più gloriarmi, che d'essere io nato nella terra dove nacque Orazio?" We have noticed a few historical slips which will no doubt be put right in a second edition. For instance, Tancred, the last Norman king, was the son of an uncle, not of a brother, of William II. (p. 22); the battle of Benevento was fought on February 26, not January, 1266 (p. 26); Pope Calixtus III. was not "Alessandro," but Alfonso Borgia (p. 66); the head of the Sanseverino house was surely not "Duke," but Prince of Salerno (p. 67). We have found most interesting and picturesque the latter part of the book, especially the chapters on "Naples under the Viceroys" (a period to which the author has evidently devoted particular attention, and about which most of us know singularly little), "The Eighteenth Century," "Naples after the Union," and "Naples To-day." Mr. Collison-Morley is at his best in depicting the various aspects of Neapolitan life in the present and associating it with the historical traditions of the past.

E. G. G.

The Story of Perugia.— **Margaret Symonds** and **Lina Duff Gordon.** 10th edition. London: J. M. Dent & Sons. 1927. $6\frac{3}{4} \times 4\frac{1}{4}$, pp. xx. + 330. *Maps and Illustrations.* 5*s.* 6*d. net.*

This is a tenth and revised edition of a well-known guide to Perugia, first published in 1897. It is a charming book, efficient and full, and gives (as every short guide should do) plenty of information as to where further knowledge may be culled. Among matters revised are the accounts of the Pinacoteca, the Etrusco-Roman museum, and suggestions for trips from Perugia; but the character of the book is unchanged: the "little powder-blue book" is successful in giving a personality to *Perusia Augusta.* In an eleventh edition Diumvir (p. 11) should appear as Duumvir or Duovir, cyppus (p. 272) as cippus, and kylyx (p. 276) as kylix or cylix. S. E. W.

Venice: Pompeo Molmenti. (The Picture Guides.) London: The Medici Society. [1926.] $8 \times 6\frac{1}{4}$, pp. 149. 7*s.* 6*d. net.*

To glance through the numerous well-produced illustrations in this book is to obtain a vivid impression of the city to-day and of its past history. Its vital alliance with the sea, the early bonds with Byzantium, its wealth and splendour as *the* commercial power in Europe, and its decline to an eighteenth-century Monte Carlo are here illustrated in its canals, buildings, and the treasures of its art galleries. Whether one will learn much more from the text, beyond names and dates, is doubtful, for its chief characteristic is the patriotic fervour of the writer: nor does it offer directions or advice to the sightseer.

Zermatt and its Valley.— **François Gos,** translated by **F. F. Roget.** London: Cassell & Co. 1926. $9\frac{1}{2} \times 7$, pp. 176. 157 *Illustrations and a Map.* 15*s. net.*

This is a book on alpinism in general and on Zermatt, "the Holy Land of alpinism," in particular, and not the least of its merits is an excellent collection of photographic plates illustrating every variety of alpine scenery. It deals with the aspect of the valley and its town and hamlets, its legends, rustic arts, and guides, and the development of Zermatt as a pleasure resort; its first hotels, and the climbers of the Matterhorn; the Theodule pass, the Gornergrat, and the lakes. Since 1800, when G. Cade, an Englishman, created a sensation by reaching Zermatt, its fame has been on the increase, till now it is the international resort of all climbers. The style of the text is not quite English and errs slightly on the florid side; but these pages tell us most of what we ought to know about Zermatt, and if they bring more visitors there the author will have achieved a part at least of his patriotic purpose.

The Faroe Islands.— **G. H. Harris, M.A.** Birmingham: Cornish Brothers, Ltd. 1927. $7\frac{1}{2} \times 5$, pp. 120. 4*s.* 6*d. net.*

For their size the Faeroes are acquiring quite a considerable "literature." This latest volume gives an interesting account of a three-weeks' visit to these islands of alternate fog and storm, particularly of the birds and plants encountered; but no book of this description should be issued without a map of some sort. The author made friends with the hospitable and genial islanders, whose Viking blood seems to be stirred to ferocity only by an occasional whale-hunt—a gory and repulsive affair.

In the historical chapter we should have liked to hear more about the Færeyínga Saga; and some account of the Faeroese language would have been welcome. (Is the author right in saying that the termination *-ur* as in *Hestur* is the definite article?) The spelling of the place-names is unsatis-

factory, being in some cases neither Danish nor Færoese: *e.g. Suderoe* for *Syderø*, Fær. *Suðuroy*, *Naalsoe* for *Nolsø*, Fær. *Nólsoy*; and *Thorshavn* is not usually anglicized into *Thorshaven*. The title of the islands themselves has always been a difficulty, "island" being already present in the word *Faeroe*, which means "sheep island." If neither the Danish *Færøerne* nor the local *Føroyar* (*Foroya* according to the author) be adopted, the P.C.G.N.'s decision *The Faeroes* seems to be the best solution. J. H. R.

Europe in the Nineteenth Century (1789–1914).— A. J. Grant and **Harold Temperley, Litt.D.** London: Longmans, Green & Co., Ltd. 1927. 9 × 5½, pp. xix. + 570. *Maps.* 12*s.* 6*d. net.*

The interest of present-day historians in foreign policy and international relations is easily understood, as also is their interest in the Napoleonic period for the close parallel it affords with recent events. The value of this very readable survey is in its summary of the latest research and documentary materials on the diplomacy of the last century. It is less a history of the nations of Europe than a demonstration of the perhaps inevitable failure of the Balance of Power to preserve peace, and the gradual growth of a more promising conception of international relations. As the nineteenth century draws on, this theme becomes more dominant, to the exclusion of matters of domestic politics. In writing of the antecedents of the war the authors are commendably impartial and outspoken. The enlargement of the field of conflict to include Africa and Asia, and the way in which varied interests were finally ranged in two camps, are particularly clearly described, though at times one feels that diplomatic combinations rather than the underlying forces receive most emphasis. Throughout the authors have avoided writing in the light of after events. Where a slight overlapping occurs, a divergence of opinion is sometimes apparent, which adds to the interest. The restrained optimism of their concluding references to the future of the League of Nations derives added weight from their candid analysis of international ills in the past. G. R. C.

ASIA

Prophets, Priests, and Patriarchs.— Harry Charles Luke, C.M.G. London: "The Faith Press." 1927. 8¾ × 5½, pp. xii. + 130. *One coloured and 24 plain illustrations, from photographs. Five sketch-maps and one coloured plan.* 6*s.*

All too many are the attempts to record the inner life of Palestine and Syria, but how much is superficial, often erroneous, and not uncommonly dull! Mr. Luke, sometime Assistant-Governor of Jerusalem, here presents us with "Sketches of the Sects of Palestine and Syria" which for charm and accuracy of detail surpass anything recently published. Only one who like the author, in addition to an accurate knowledge of these peoples and sects has a gift of sympathetic inquiry, could have gathered together such a mass of detail and welded it into so picturesque and charming a narrative.

The early chapters deal with the varieties of Christian sects and their recurrent struggles to maintain their respective pretensions. They mostly centre round the venerable Church of the Holy Sepulchre. A coloured plan is inserted showing the claims of the various sects to their special sections: little indeed is common to all Christendom. There is a very interesting account of the great riches in vestments, jewellery, and relics still treasured here by the Greek Orthodox and the Armenians. There are chapters on the Samaritans, on Islam in Palestine, and on the "Rayahs" in the Ottoman Empire.

The most original chapter in the book is that on the "Old Man of the

Mountain." The story of the rise of the *hashistun*, or "Assassins," is told with considerable detail and continued through the days of their power down to the sad condition of their "cowed and rather pathetic" modern descendants gathered round the ruined stronghold of Masyad. E. W. G. M.

When we lived in Jerusalem.— Estelle Blyth. London: John Murray. 1927. 8 × 5½, pp. xii. + 348. *Eight Illustrations.* 12*s. net.*

This is a brightly written collection of memories of many years spent in Jerusalem under the peculiar conditions obtaining before the War. It will be of special interest to those who shared the same experiences, and many incidents, now half forgotten, will be pleasantly recalled. The Introduction—the most important chapter of the book—is devoted to an all-too-brief record of Bishop Blyth's work as Anglican Bishop (1887–1914). There are passing references to many notable visitors to Jerusalem, including some quaint sayings of Armenian tourists; many references to political and ecclesiastical events, and some account of native life and ways. No one who knew Jerusalem in pre-war days should miss the book. There is a curious slip on p. 342. It was not to Ananias and Sapphira that the words were said, "Thy money perish with thee"!

China in Turmoil: Studies in Personality.— L. M. King. London: Heath Cranton, Limited. 1927. 8¾ × 5½, pp. 233. 19 *Illustrations.* 10*s.* 6*d.*

Mr. King has recently retired from H.M. Consular Service, where he was at various times stationed at Peking, Shanghai, and Canton, but he spent the major part of his time in the remote interior—Chungking, Chengtu, and the Tibetan frontier. He has chosen to give the cream of his reminiscences as a series of delightful pen pictures of selected types. The members of each type selected for description are not named: only the illustrations give the clue that General Ch'en Hsia-ling is "The Autocrat" of chapter i. or General Yin Ch'ang-heng "The Philosopher" of chapter xvii. There is little that is geographical in the volume, but as a study of the personal factor in the rebirth of China it is wholly admirable. L. D. S.

AFRICA

Algeria from within.— R. C. Bodley. London: Hutchinson & Co. [1927.] 9½ × 6¼, pp. 320. *Thirty-one Illustrations and Folding Map.* 21*s. net.*

This interesting volume is written by one who, having lived long in Algeria —though how long the book nowhere reveals—professedly sets out to tell of the inner life of its people. Not, however, till the third and smallest part of the volume is this promise really redeemed. The first part consists of chapters on Algerian geography, history, and life, giving little more than is familiar from the best guide-books, and with a tendency to generalize and exaggerate more characteristic of the tourist than we should have expected from this writer. Thus we read of "The enormous proportion of Arabs who speak fluent French"; that "A rainstorm in the Mzab is worth millions to its inhabitants"; "One finds practically the whole of the Old Testament in the Koran"; and the like.

The second part outlines a suggested tour which likewise does not stray far from the beaten track familiarized by the "Transatlantique" tours, though it is well calculated to inspire a desire to visit the places described.

So far, then, we have only a book we might recommend as useful to the tourist, but of no special interest to the student. But the third part (Sketches of Arab Life, pp. 268–320), slight as some of the sketches are, is a dessert

which amply atones for the somewhat solid *entrée* and joint. It is full of interest, and reveals a real inner knowledge of Arab and Berber alike.

There is a good story on p. 109 at which the Prohibitionist will chuckle, and though the writer prefers the Paradise of the Moslem to "our rather vague golden city," he very fairly and truly remarks (p. 138) that the white Fathers and Sisters "have done more to pacify the country than any soldiers or politicians."

The map, as is so sadly often the case, lacks both clearness and relevancy to the text; many of the photographs are specially good; the literary style is pleasant, though some phrases jar. "Administrated" is an unnecessarily ugly variant for "administered"; common solecisms of the form "go and see" for "go to see" abound; and "how far these conquests would have continued it is difficult to say had not Genesric died" is a specimen of confused construction.

But these are small blemishes upon an eminently readable book.

W. C. P.

AMERICA

A Book of Old Maps delineating American History from the Earliest Days down to the Close of the Revolutionary War.— Compiled and edited by **Emerson D. Fite,** Professor in Vassal College, and **Archibald Freeman,** Instructor in Phillips Academy. Harvard University Press. (London: Humphrey Milford.) 1926. 16½ × 12, pp. xvi. + 288. *Index.* £5 5*s.*

This work consists of seventy-five plates, twenty-three of which are world maps, or reproductions of globes, varying in date from the Ptolemy map of 1474 to 1600. The remainder range from general maps of America to Penn's plan of Philadelphia; fifteen deal with the revolutionary period.

The plates are reproduced by photography, and thus have the authority so often lacking in the past to copies made by hand. The printing is in general excellent; in the larger and in the less perfect maps a good deal of detail is necessarily unreadable, but the more important legends are reprinted in the text and translated where necessary into English. Each map is accompanied by a careful analysis in which original authorities and recognized critics are freely quoted, the editors finally arriving at their own conclusions, which often differ from generally accepted theories. Here they show commendable courage and, in the reviewer's opinion, are often right. We may, for instance, agree that there is some foundation to Juan de Fuca's story of the Strait on the Pacific coast; it is quite incorrect, however, to say that his exaggerated story of a connection with the Atlantic was disproved by Spanish navigators. The situation was cleared up mainly, if not wholly, by Captain George Vancouver.

Maps are classed as Anonymous if the authorship is not very clearly known, but less care is shown in regard to dates. The large Hondius map in hemispheres, for instance, is definitely ascribed to 1611, although this is but a plausible suggestion. Later we read, "Hudson's voyages to Hudson River and Hudson Bay, 1608–10, are not mentioned, though the date of the map is 1611." A map published in Holland in 1611 might easily omit Hudson's last voyage, as the survivors did not reach England till September in that year. This Hondius map is very faint, and one of its most interesting features, the interior North American Sea, can hardly be discerned.

The map illustrating Sir Humphrey Gilbert's "Discourse of a Discoverie for a new Passage to Cataia" is dated as 1576, the year it was printed, although the Discourse was written ten years before. It is described as anonymous, and, from the remark that it was "Made Onelye for the Particuler Declaration

of this Discovery," the editors conclude that it is imaginary. This is incorrect: the map is evidently based on the Ortelius map of 1564, a copy of which is now in the British Museum. The "generall Mappe" of the world, published in 1578 with Captain Beste's account of Frobisher's voyages, is also classed as anonymous. The following sentence is quoted from the title-page of Beste's book to account for the omission of lines of latitude and longitude: "With a particular Card [thereunto adjoined of *Meta Incognita*], so farre forth as the secretes of the voyage may permit." As the words in brackets have been left out of the quotation, the "particular Card," which is a large-scale map of Meta Incognita, has evidently been confused with the "general Mappe" of the world mentioned by Beste in a previous sentence. In this Beste shows the equator, the tropical and polar circles, and in omitting the other lines merely follows the example of Sir Humphrey Gilbert.

The Hondius map of the Drake and Cavendish circumnavigations is another of those reproduced. Drake's Bay, in California, is definitely accepted as the careening ground of the *Golden Hind*, although, as Mr. Wagner has recently pointed out, there is a good deal of doubt about this identification. There is no mention of Professor G. Davidson, who wrote so much about Drake's Bay and arranged for the name to be officially adopted.

An interesting series of maps deals with the supposed insularity of California, but the "Sea of the West," the other great myth of the Pacific coast, is somewhat neglected.

The Preface, borrowed from Mercator's Atlas of 1633, happily describes the work as "composed of Geographie . . . and Historie . . ., which, parted asunder, menace a shipwreck of our content, and are like two Sisters intirely loving each other, and cannot without pittie be divided."

This idea is kept in mind throughout. No attempt is made to deal with the major facts of history; these are left for others to determine from the evidence which has been so carefully collected and intelligently discussed. But this evidence, it is clear, goes far to show that, for more than a century after Columbus thought he had reached the coast of Asia, the history of North America was affected as much by the imaginary geography of the continent as by its actual shape, extent, and position.

The editors evidently try to steer clear of that bias which, we have recently been told, makes history so interesting. They seem, nevertheless, to lay a good deal of emphasis on the American revolution, possibly on account of the many interesting maps that event gave rise to. But in 'The Genesis of the United States' Alexander Brown shows that the struggle with Spain, which won for the Anglo-Saxon a footing on the continent, was an event of far greater importance in the history of mankind, and this point of view was evidently shared by Admiral Mahan, his eminent fellow-countryman. R. P. B.

The American Indian. North, South, and Central America.— A. Hyatt Verrill. New York and London: D. Appleton & Co. 1927. 8 × 5½, pp. 485. *Illustrations.* 12*s.* 6*d. net.*

Mr. Verrill sets out to give a popular account of the manners and customs of the native tribes of the three Americas; in his descriptions of the ways of certain folk the volume may be useful, but his work is deprived of value for the serious student from the first chapter, in which arguments regarding the origin of the American "Indian" ignore the evidence of the trained ethnologist. Looseness of phrasing characterizes the book throughout, and it is obvious that the author has not gone deeply into his subject in any phase of aboriginal life,

whether he discusses the marvel of pottery "made solely by the eye," or the joys of markets where "a gloriously good time is had by all." However, the author repents him of the evil of the white man's dealing with the native folk, and ends upon a rhetorical note: "Why should we not be fair and give the Indian his due, now that both white and red are at peace and our country's Indian sons have fought so gallantly for our flag? Why not respect the Indian for his gallant but ever-losing struggle . . . ?" Why not, indeed?

AUSTRALASIA AND PACIFIC ISLANDS

Islands near the Sun.— Evelyn Cheeseman, with photographs by **L. Gauthier** and sketches by the author. London: Witherby. 1927. 9 × 6, pp. 236. *Map and Illustrations.* 12*s.* 6*d. net.*

In April 1924 Miss Cheeseman accompanied the St. George Expedition as a member of its scientific staff. She left it at Tahiti, and thenceforward concentrated her activities on three islands of the Society Group. This volume is a record of her entomological explorations in the islands of Tahiti, Raiatea, and Bora Bora.

Her narrative is eminently readable and full of information of general interest. The descriptions of tropical scenery and vegetation give a clear impression of these beautiful islands. We learn much about travel in coral-strewn waters. We are told about the lives, the character, the folk-lore of the natives, their customs, their diseases, and reaction to civilization. There is a particularly attractive account of Lake Vaihiria, which the natives believed to be frequented by eels decorated with human ears.

Miss Cheeseman forced her way into the interior, following along trails and narrow pig tracks. We cannot but admire her enthusiasm and enterprise. She is alone, and all is not plain sailing. She has to adapt herself to native customs. We learn what life in a palm-leaf hut is like. We see her collecting in spite of wounds and sickness, cutting her way through dense tropical scrub and getting into precarious positions on the face of dangerous slopes. Her capacity for enlisting native sympathy must have served her in good stead. How she undertook the duties of sanitary instructor, how the padre made her the subject of his sermon, indicate the degree of confidence she gained.

Entomological observations are scattered through the volume. We wish that Miss Cheeseman had added more. She made large and valuable collections, but we should have liked more of those field observations which Miss Cheeseman is so eminently fitted to supply. When she tells us of those ants which so divide their energies that one group makes a martial ring around its spoil while the other group carries it piecemeal away she makes us regret that more observations of the kind had not found their way into this volume.

R. W. G. H.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

The Elements of Geology.— Mary A. Johnston. London: Thos. Nelson & Sons, Ltd. 1927. 7½ × 5, pp. 285. 118 *Illustrations.* 3*s.* 6*d.*

In this little book, intended "for those who are young in the study of geology, however old in years they may be," an attempt is made to give a popular account of the historical geology of the British Isles, introducing incidentally the elements of physical geology. The difficulty of the method lies in the fact that the history must commence with the most complex of all rock systems, the Pre-Cambrian. Yet the reader must wait till he reaches p. 168 before being introduced to the meaning of dip and strike.

The somewhat florid style is apt to seem forced to the adult reader, and must, we fear, result in much confusion in the minds of younger readers. Actual errors are few, but the author has not entirely escaped the pitfalls open to the enthusiastic amateur. "Oldham" for Oldhaven occurs on pp. 201 and 261; whilst the "Norfolk Crags" are not the principal Pliocene of England (p. 261). The Glossary needs careful revision. The book is well printed and illustrated by numerous photographs, many of them by the Geological Survey.

L. D. S.

HUMAN AND HISTORICAL GEOGRAPHY

Sir Francis Drake.— E. F. Benson. (Golden Hind Series.) London: John Lane. 1927. 9 × 5¾, pp. xiv. + 316. *Maps and Illustrations.* 12*s.* 6*d. net.*

This volume, well printed and with nine illustrations from contemporary sources, constitutes the first of "The Golden Hind Series." The general editor, Mr. Milton Waldman, explains that the seven volumes by different authors will make "no pretence to bibliographical discoveries," but will present narratives, at once authentic and readable, of the chief Elizabethan navigators and explorers. Mr. Benson's volume fulfils the editorial promise; for in 315 pages he tells brightly and often amusingly the story of Drake's adventurous career. Where so much is doubtful or obscure, good sense rather than great learning is the chief desideratum; and good sense generally marks his discussion of disputable points. Thus, as regards the date of Drake's birth, there is much to commend his fixing on the year 1541. It is generally conceded that Drake's family was "in a small way," had to fly from Tavistock owing to a local Catholic rising, and settled near Chatham. But on these scenes of his boyhood we are (as Mr. Benson says) "playing blindman's-buff in boggy places."

There is almost as much uncertainty, however, about later episodes; and as to some of them Mr. Benson would have done well to be very cautious. It is possible, for instance, that the Spanish version of the S. Juan d'Ulua treachery may, when fully known, supply some mitigating details; and, in any case, the relentless methods then prevalent of dealing with interlopers in Spain's preserve should be taken into account. On the other hand Mr. Benson seems justified in differing from that excellent authority, the late Sir Julian Corbett, as regards the site of Puerto escondido and Drake's mysterious doings in Ireland. On the question of the trial of Doughty, he is frankly "Drakian," and probably with justice if the crucial importance of maintaining strict discipline is borne in mind. Of course the evidence on the whole affair is incomplete, *e.g.* whether Drake had authority to inflict capital punishment; but the practice of the time warranted its infliction in case of disobedience tending to mutiny. Incidentally, Mr. Benson is perhaps scarcely justified (p. 136) in asserting that Sir Julian Corbett stated that Burleigh was behind Doughty's actions. Undoubtedly Burleigh wanted to prevent further provocation to Spain, but he would surely not have dared to instigate mutiny, or something like it, in a voyage known to be countenanced by the Queen. Doughty, a vain man as well as an intriguer, probably went far beyond any hints that Burleigh may have dropped as to his dislike of the enterprise. It is a far cry from that to the instigation of mutiny, which Sir Julian did not attribute to Burleigh. Indeed, in his non-committal statement on the subject, he admitted that Doughty "may have been acting on his own initiative." That Drake did not act without justification there is one inferential proof not mentioned by Mr. Benson, viz. that after the voyage no charge of murder was brought against him by Doughty's kinsmen and powerful connections.

Mr. Benson (p. 164) doubts whether Drake was much set on finding a northern passage back round North America to England. Here again there is no direct evidence; but Drake's pressing north to lat. 48° in the teeth of bitterly cold winds seems to imply such a desire. So too does his annexation of New Albion. Frobisher was searching for the North-West Passage from the Atlantic; and so eager an explorer as Drake was certain to try to rival him from the Pacific. Failing to sight S. Juan de Fuca Strait, Drake thereupon thought of bringing his precious cargo home the readiest way, which was by the Moluccas. But his annexation of the "Elizabethides" by Cape Horn and of New Albion near the presumed northern passage called for more comment than is here given.

Drake's dash at Cadiz in 1587 and his very important share in the Armada episode are briefly described. The Queen's halting procedure is duly castigated, but Howard receives barely his due for finally adopting, and then firmly practising, Drake's bold and sound strategy. Mr. Benson, for all his love of the picturesque, rightly rejects the popular story that Drake insisted on finishing that (legendary) game of bowls on Plymouth Hoe when the Armada was announced as already ranging the Cornish coast. Of course every minute was precious, and Drake and Howard hustled out the English fleet barely in time to gain the windward position, which meant everything. Mr. Benson has written a readable account of our first naval hero; it is sometimes disfigured by slang (*e.g.* p. 63, "they (the Cimaroons) would tell their tribe there were some nice young men [Drake's] knocking about"); but he is sound on essentials, and well brings out the greatness of this daring son of Devon.

J. HOLLAND ROSE.

The Corridors of Time. I. Apes and Men. II. Hunters and Artists.— H. Peake and **H. J. Fleure.** Oxford: Clarendon Press. 1927. 8 × 5½, pp. vi. + 154; vi. + 138. *Maps and Illustrations.* 5*s. net each.*

These little books are the first two of a series of four written conjointly by the authors. They state that their object is to attempt a review of the more general aspects of the detailed studies of anthropologists and geographers, archæologists and historians, as applied to the interpretation of civilization. Among the subjects included in their review are the Origin of Man, Changes of the Earth in geologic time, the Descent of Man, the Ice Age, Early Tools and late Palæolithic Industries, Early types of Man and of Modern Man, Palæolithic Art, Palæolithic Survivals and Late Palæolithic Invaders of Europe. These are sufficient to show the wide scope of their efforts. As they are expressed in less than 300 small pages, the text of which is considerably broken by the interpolation of 126 illustrations, twenty-seven of them full page, it will be realized that the work is highly condensed.

One great object of the authors is apparently to equate the different periods of Prehistoric man's existence with the Pleistocene glaciations of Western Europe. Considering the uncertainties and differences of opinion regarding the so-called Ice Age this is no easy task, and their views, which culminate in a very definite chronological table in thousands of years for the Wurmian Glaciation, are hardly likely to escape criticism. Until much more unequivocal evidence is forthcoming, current speculations regarding the Ice Age, especially in regard to time, are confusing rather than convincing. A good example of this is seen in the fact that, whilst the authors give 7000 B.C. for the final stages of the Wurmian advance, the latest authority, Soergel, puts it at 70,000!

Prehistoric industries, the remains of Prehistoric man himself, and his migrations are other leading topics. The tendency nowadays evinced by

anthropologists to generalize on very few data, especially regarding the races and migrations of Early Man, is not altogether avoided by the authors, though they are evidently alive to the danger of this pitfall. The views they advance on migrations generally appear to be decidedly speculative. In deprecating the inclusion of all or most of the examples of Upper Palæolithic Man in one group—the Cro-magnon—they are well justified, and their protest is timely considering the way in which the term is being used by all kinds of writers on Anthropology, Geography, and History; any unprejudiced observer cannot fail to be struck with the marked differences in the human remains of this period. Their attempt to show the relationship of Capsians, Aurignacians, Azilians, and Tardenosians is interesting and ingenious, but necessarily quite provisional.

Any attempt at synthesis of the mass of prehistoric material that has accumulated in recent years is to be welcomed, and may be serviceable when made in the impartial spirit shown by the authors. Yet this very activity of prehistoric research, with its resulting differences and difficulties, has had the effect of producing an instability and uncertainty regarding many important prehistoric problems which make one regretfully feel that the time has not yet come when any very certain conclusions can be drawn regarding the Races and Migrations of Palæolithic Man. E. A. P.

The Mechanism of the Modern State: a treatise on the science and art of government.— Sir J. A. R. Marriott. 2 vols. Oxford: Clarendon Press. 1927. 9 × 5¾, pp. xxiii. + 596; xii. + 595. 42*s. net.*

The main theme of this work is the history, development, and practical working of the British Constitution, though the inclusion of comparative studies of other forms of government, including those of the Dominions, justifies the wider title. The enjoyment of an unwritten constitution, and the wide range of modern state activities might well excuse ignorance on the part of the ordinary citizen of the administrative machinery of his country; here, if he so desires, he will find a clear exposition of its working, illustrated by the author's own political experiences. The appendices containing specimens of Rules, Orders, Treasury Minutes, and other official documents will be especially useful in this connection. The work forms a complement to the writings of Bryce and Dicey.

GENERAL

Whaling North and South.— F. V. Morley and **J. S. Hodgson.** London: Methuen & Co. 1927. 9 × 5¾, pp. xviii. + 229. *Illustrations and Maps.* 10*s.* 6*d. net.*

The two authors of this book write from personal experience. Mr. Morley made some cruises from a Shetland whaling station, and Mr. Hodgson spent a season with the Norwegian whalers around South Georgia and the South Shetlands. A love of adventure and a desire to take moving pictures were the incentives. The result is a very readable book which surveys the modern aspect of the whaling industry and gives some account of its history. The most vivid chapters are those describing whaling in South Atlantic and Antarctic waters and experiences in the South Shetlands. The historical chapter is a mere sketch, and has little reference to Arctic whaling except in Spitsbergen waters. Whaling in Baffin Bay and in Alaskan waters is scarcely mentioned.

Mr. Hodgson, who was a flying officer during the war, advocates the use of seaplanes in pelagic whale hunting. He suggests that the planes should

scout for whales and communicate with the whale catchers by Verey lights or wireless. Experiments in the use of an aeroplane for whale spotting near Saldanha Bay are said to have shown that whales can be sighted 1000 feet below the surface. By this means the author believes that whaling could be made more profitable. Doubtless also it would lead rapidly to the extermination of the whales.

In his account of the southern whaling grounds Mr. Hodgson has made a few slips. Sir Francis Drake did not search for a southern continent or, as he implies, get a view of the South Shetlands. The seals which the Americans (and others) almost exterminated at the South Shetlands about a century ago were fur seals and not Weddell seals. They paid no attention to the latter, which have never been seriously hunted. Lastly, there is no reason to call Port Lockroy "the most southerly harbour in the world." But these are minor points in a volume which is a useful contribution to the literature of whaling. There are many excellent photographs, but the illustrated maps are more picturesque than adequate. R. N. R. B.

Travels in Spain and the East: 1808–1810.— Sir Francis Sacheverell Darwin. Cambridge: University Press. 1927. 8 × 5, pp. ix. + 121. *Frontispiece and Sketch-map.* 6*s. net.*

This slight but entertaining account of a journey in Mediterranean lands gives a good picture of a worthy of the days before specialists. Sir Francis Darwin not only braved what must be considered as the ordinary perils of travel at an unsettled time—he landed at Corunna and worked southwards while Sir John Moore's force was actually in retreat—but in pursuit of knowledge faced additional risks. Incidentally, his account shows the extreme bitterness which marked the Peninsular struggle. When at Granada, he undertakes the ascent of a summit in the Sierra Nevada, and setting out "prepared with a bottle of laudanum, nails in my shoes, a hammer and a stick," spent a most uncomfortable night at the top, and when descending next morning was nearly shot by guerillas. At Tetuan, he made a post-mortem on a poisoned dog, later spent several days in the Smyrna hospitals during an epidemic of the plague, collected objects of archæological interest, and examined with some care a seam of coal near Constantinople. Yet of all he saw he writes, as befitted his times, with a most restrained enthusiasm, and one feels that his neglect, lamented by his editor, to write down his impressions of Byron may have arisen from another cause than a failure to foresee the interest of future generations.

A Novelist's Tour of the World: Vicente Blasco Ibañez. Translated by **L. Ongley** and **A. Livingston.** London: Thornton Butterworth, Ltd. [1927.] 8½ × 6, pp. viii. + 420. *Illustrations.* 21*s. net.*

Perhaps the obvious criticism of this rather formidable narrative is suggested by a remark in the opening chapter, which the author's "ironic self" addresses to him, that, instead of setting off round the world, he has only to step into his library with its twenty thousand volumes. Despite this hint, he set out, wishing to see the things of which he had read, to wander as a nomad, and—to return and write of it all once more—as a novelist, not an economist, he is careful to point out. The book contains, besides description and narrative, much history, and some observations upon current events. When asked on his return what definite lesson he had learnt, the author replied that he had been visiting the battlefields of the future—India, China, the Pacific.

A Colonist's Voyage to New Zealand under Sail.— A. Fell. Exeter: J. Townsend & Son. London: Simpkin, Marshall. [1926.] 7½ × 5, pp. 112. *2s. 6d. net.*

Sir Arthur Fell adds a preface to the diary of his father of his voyage to New Zealand in the early 'forties. Mr. Fell had a four months' journey in a sailing ship and landed, as one of the first settlers, at Nelson. The voyage was uneventful and the book is slight. Interest lies only in the contrast between life on a sailing ship of some 600 tons and the more familiar journey on a large modern steamship. Lack of water and cramped accommodation were the chief drawbacks, for the food was excellent and the captain and passengers got on well together.

A Complete School Geography.— E. G. R. Taylor. London: Methuen & Co., Ltd. 1926–7. Two Volumes. 7½ × 5, pp. (1) xiv. + 352; (2) x. + 434. *Maps and Diagrams.* *5s. and 5s. 6d. net.*

Apart from a disarming paragraph in the Introduction, the general trend of Miss Taylor's 'Complete Geography' shows the sense in which the epithet is to be understood. Our intention is to be complimentary when we say that we wish it had been less "complete" in that sense, viz. in the attempt to cover "all aspects of geography which it is reasonable to expect should be mastered during the crowded school years." For, merely with an eye to the examination system, our own experience is that the matter most likely to be retained from a book of this kind, and most likely too to "score" with an examiner—surfeited with the monotony of the stereotyped answer—is to be found precisely where the author lets herself go along the lines of her own enthusiasms, or, better still, evokes, as it is clearly the purpose of this book to do, original work on the part of the reader. As it is, we have come across no school book which should open up for the student so many vistas of interesting by-paths to be explored with the aid of the thorough system of cross-references and the suggestions for further study provided. These features, valuable in themselves on educational grounds, have further, by the economy thus afforded, enabled Miss Taylor to convey an amount of information which should carry the student a good deal beyond a Matriculation standard. Small mistakes there are bound to be in a first edition. Star-tracks are not inclined to the horizon of London at 51½°, but at the complementary angle (**1**, p. 9). Hungary is not a republic, but a monarchy held in trust by a regent (**2**, p. 19). The division in Dela-goa (and the suggested connection with Goa) is fallacious. Lagoa is Portuguese for lagoon, while Goa is a native name (**2**, p. 310). We are glad to recognize that it has not been easy to find such errors, and the proof-reading has been carefully done. Some rather dull statistical facts, notably in chapters i. and xxx. of the second volume, might better have been thrown into tabular form in an appendix, to make way perhaps for some more of those delightful glimpses into original work which, as we have said, constitute for us the charm and value of this book. Apart from many smaller items of interest, we like best such general chapters as those on Natural Vegetation, Animals and Man, and the Growth of Civilization, while we find especially admirable the "Home District" study (**1**, chapter vi.), well chosen and illustrating very completely all that may be legitimately deduced from a topographical map. Altogether this is a noteworthy contribution to the ranks of school text-books. A. J. P.

THE MONTHLY RECORD

EUROPE

Glacial Geology of South-West Scotland.

DR. J. KAYE CHARLESWORTH, Professor of Geology in Queen's University, Belfast, contributes a paper on the " Glacial Geology of the Southern Uplands of Scotland, West of Annandale and Upper Clydesdale " to the *Transactions of the Royal Society of Edinburgh*, vol. 55, Pt. I., Session 1926–27. This portion of the Uplands was glaciated mainly by local ice centred in the Merrick, Corserine, Cairnsmore of Carsphairn and Lowther Hills. From this axis the ice radiated outward, to the south along the Cree, Ken, Nith, and Annan ; to the north, along the Upper Clyde, Lugar, and Doon ; and to the south-west, by the Stinchar and Girvan. The glaciers flowing to the north-west were deflected by the northern ice in the Firth of Clyde through west into south-west, and forced to pass over the Rhinns of Galloway. On the other hand, those issuing southward were pressed by the ice in the Solway Firth, to which they themselves largely contributed, to flow southward over the Machers of Wigtownshire, and eastward from Criffell along the northern shores of the Solway Firth.

When the retreat of the great ice-sheets was in progress, the local ice split up into a series of more or less independent glaciers occupying the valleys already mentioned. Their stages of recession are indicated by well-marked moraines, which are shown on a map accompanying Dr. Charlesworth's paper. In the Cree valley the moraines fall readily into five distinct stages, named after localities where the best development is found, and the same stages were discovered in the other valleys and correlated with those of the Cree. The absence of some of the outer moraines in the regions of the northern glaciers, from the Clyde to the Stinchar, is ascribed to the confluence of these glaciers with the Highland ice during the earlier stages, whilst the partial development of the outer moraines in the Solway area indicates similarly the union of the adjacent glaciers to form a broad piedmont fan spread over the floor of the Solway Firth. Certain discordances in the trend of the drumlins of one of the stages, together with various corrie moraines, are considered to denote a re-advance of the local ice of possibly considerable magnitude. The late-glacial sea-beaches of the region are traceable to heights varying from 60 to 100 feet above the present sea-level. The positions of the climatic snow-line of the area during the various stages of the retreat are estimated as approximately from 900 to 1500 feet above the present sea-level. It may be noted for comparison that the present theoretical snow-line in Scotland seems to be about 6000 feet or less, seeing that the 4000 feet plateaux in the Highlands reach the zone of " outliers " harbouring permanent snow-beds.

Another paper by Dr. Charlesworth in the same issue of the *Transactions* is entitled the " Readvance, Marginal Kame-moraine of the South of Scotland, and some later Stages of Retreat." It discusses the conspicuous " Lammermuir-Stranraer Moraine " which, margining the Central Valley on the south, has been traced from the east coast, south of St. Abb's Head, along the northern slopes of the Lammermuir and Moorfoot Hills to the Clyde above Lanark, and by Muirkirk to the hills near New Cumnock, occurring again, after a break in South Ayrshire, at Stranraer and in the Rhinns of Galloway. It is this break which implies the confluence of the Highland ice with the glaciers centred in the western part of the Southern Uplands as explained in the first paper. The ice-sheet at the stage represented by the moraine in question was

still very powerful. It filled the Central Valley, overrode the Pentland Hills, abutted against the northern flanks of the Southern Uplands to an altitude exceeding 1000 feet above sea-level, excluded the shallow seas on the west, and spread some distance over the floor of the North Sea on the east. During the recession the higher Pentland summits appeared as nunataks.

Reclamation of the Zuyder Zee.

The progress of the great scheme for the reclamation of the Zuyder Zee is recorded in an article by R. Schuiling in the *Tijdschrift* of the Dutch Geographical Society for July 1927. The writer's main subject is the past history and present condition of the island of Wieringen, but this island is also an important factor in the scheme. Wieringen, being close to the North Holland coast, is composed of low banks of diluvial boulder clays and sands running north-east for 9·5 km. and rising to a height of 13 metres in the south-west. Its total area is 2506 ha. Along the south side several polders have been drained: agriculture, dairying, and the gathering of seaweed (from which the island takes its name) are the occupations of the 3300 inhabitants. This population gives a density of 133 per sq. km., a figure greatly above those for other Dutch islands, which augurs well for the future of the areas to be reclaimed. The main offices are established on the island. The dyke connecting the western end with the mainland has already been completed, as well as the subsidiary ship and water-supply canal along the North Holland coast. Work has also started upon the eastern end of the island, whence the 30-km.-long dyke strikes north-east for the Friesland coast at Zurig, south of Harlingen. This is farther to the north than was originally planned. The dyke is to be raised 7·5 metres above sea-level, and will be provided at either end with sluices capable of passing vessels of 600–2000 tons into the Ijssel Meer. The work is estimated to require eight years altogether. Under the scheme, polders with an area of 25,000 ha. will be created to the south of Wieringen, the first land to be reclaimed, and an experimental school is being established at Medemblik. It is expected that in thirteen or fourteen years the land will be yielding full returns. The paper has illustrations, sketch-maps, and geological sections.

Sixteenth-Century Maps of Germany.

New light continues to be thrown on the beginnings of detailed cartography in the sixteenth century, about which extremely little has hitherto been known. Among the more obscure cartographers whose work has in some cases been known only through references to it by Ortelius and others, are various members of the German family of Zell (also written Zellius, Zelius, Zeelen, Cella, etc.), the most active of whom in this line appears to have been Heinrich Zell, his relatives Urban, Ancelm, and Christopher appearing rather as publishers than actual makers of maps. The work of the first named was discussed last year in *Petermanns Mitteilungen* (vol. **72**, pp. 63–66) by Prof. L. Bagrov, who in 1923 became the fortunate owner of a large, previously unknown, map of Europe (probably of about 1535 or 1536) bearing the names of Urban and Christopher as publishers, but which he considered to be really the work of Heinrich. The latter was certainly the author of a large woodcut map of Germany, dated Strassburg 1560, of which the only copy known so far is preserved at Dresden, and Prof. Bagrov assigned to him also two smaller and rougher maps (one in German, the other in Latin) without name of author or publisher, but both dated 1550. They are thus earlier than Gastaldi's well-known map of 1552, which Bagrov considered to be copied from them, thus

making Zell the fountain-head of most of the maps of Germany of the second half of the century. In a more recent number of *Petermanns Mitteilungen* (1927, Heft 7/8) Sig. G. Caraci of Florence takes up the subject, and expresses great doubt as to the correctness of some of Bagrov's conclusions. While admitting a certain relationship between all the maps in question, he points out with justice that there is no adequate ground for attributing the anonymous maps to Zell, and that anyhow they could not in themselves be the basis for the very much more detailed map of Gastaldi. The great improvement in the map of 1552 as compared with that in the Ptolemy of 1548 (also Gastaldi's work, and itself dated 1542) shows that the cartographer had acquired much new information in the interval, and he is said, in fact, to have brought out in 1546 a large map of the " Impero " printed at Venice by Matteo Pagano. The relationship of the maps in question can best be explained by supposing that all derive from a now unknown common source, and Caraci thinks it quite likely that this was the work of Gastaldi himself. At the end of his article he describes briefly, with facsimile reproduction, another of Zell's maps—one of Prussia dated 1542—of which one copy only appears to be known, preserved in the Biblioteca Marciana at Venice. This is evidently the " Brussiae tabula Henrici Zellij Norimbergae excusa " spoken of by Conrad Gesner (among other maps of the Zells) in a work of 1548.

Even if some of Bagrov's conclusions may be untenable, his article is valuable as bringing together all that is known of the life and work of Heinrich Zell, who, after residing for a time at Danzig and being associated with the school of Copernicus, matriculated at Königsberg in 1555 (he is described in the register as " Mathematicus excellens et Cosmographus ") and became Librarian to Duke Albrecht. He died in 1564.

ASIA

Explorations in North-East Siberia.

The July 1927 number of the *Zeitschrift für Gletscherkunde* contains a short account by Mr. S. V. Obruchev of explorations in 1926 in the region of the Indigirka and Kolyma rivers in North-Eastern Siberia, which have proved our existing maps of this region to be very incorrect. In particular (besides representing the river-courses quite inaccurately) they fail to show an important mountain chain, the highest in this part of Siberia, which runs athwart the Upper Indigirka between its right-bank tributaries the Moma and Nera. Instead of flowing, as has hitherto been supposed, through a low-lying plain, the Indigirka cuts through nine successive ranges, reaching in parts a height of some 10,000 feet (3000–3300 metres), and covered with perpetual snow, the lower limit of which was in August and September at an altitude of 1600 metres. No glaciers were seen, but small ones were reported to exist. Their small extent in ranges of such height in so northerly a latitude may be explained by the dryness of the climate. In conjunction with previously known ranges to the east and west this new range forms an unbroken inner arc parallel to the outer arc composed of the Verkhoyansk–Kolymsk–Anadyrsk range, which it much exceeds in height, and its total length is at least 1000 kil., with a breadth of 300. Evidence for a very extensive former glaciation of this region was obtained, the landscape being a typical glacial one. In each of the two main ranges the breadth of the glaciated area reaches 300 kil., the ice having probably coalesced in the intervening depression. On the Indigirka the moraines were laid down before the formation of the lowest river terraces, but an upper series are pre-glacial, and thus prove the new range to have been elevated before the

Ice Age. Taken together with results recently obtained by other travellers in other parts of the country, Mr. Obruchev's observations show that the glaciation of Northern Siberia was much more extensive than has been supposed.

Rainfall Types in the Dutch East Indies.

Observations for at least five years have been made at nearly 2800 rainfall stations in the Netherlands Indies, of which 2200, or thereabouts, are in Java and Madura. Tables and maps of the mean monthly and yearly rainfall of these stations have for some time been published by the Royal Magnetic and Meteorological Observatory at Batavia. A recent publication of the Observatory in Dutch and English (Verhandelingen, No. 18) by Dr. J. Boerema, discusses the yearly range of the rainfall in the various parts of the archipelago, giving for many purposes a much clearer view of the distribution than is to be had from the earlier publications. The present paper contains two maps, a more detailed one for Java and Madura, and a more general one for the rest of the archipelago, showing a large number of types of seasonal distribution of rainfall in the form of graphs scattered over the maps. To recapitulate these types, which number sixty-nine for Java and Madura and eighty-six for the other islands, would be impossible in a brief note, and even if it were not the result would be very "dry" reading. The geographical interest of the types is in relation to the climatic factors governing the regional and seasonal distribution of the rainfall, as illustrating the great complexity of rainfall conditions in this wet equatorial archipelago. The types are the combined result of the equatorial double rainy season, modified by the well-marked monsoons of the region, and modified again by local conditions which in this mountainous archipelago are so powerful as to cause wide variations in seasonal regimen from point to point, and in some cases quite to mask the theoretical regimen based on the wider factors. The study is invaluable in exposing the fallacy of regarding tropical rainfall as merely following the simple law of the swing of the equatorial rain-belt. The theoretical position of the rain-belt and of the disturbing monsoons gives us our bearings, however, and the action of the local factors must be studied in that light.

AFRICA

Tin Deposits in Uganda and Tanganyika Territory.

The first number of the *Bulletin of the Imperial Institute* for 1927 (issued in May) contains the abstract of a report by Mr. A. D. Combe on the deposits of Cassiterite (tin-bearing ore) which have been discovered within the past three years on both sides of the boundary between Uganda and Tanganyika territory west of the Victoria Nyanza, in Ankole and Karagwe respectively. The rocks of the Karagwe–Ankolian system comprise a great thickness of ancient unfossiliferous sediments, in part metamorphosed, and folded in a complex manner. Shales form a large part of the system, but over wide areas their original character has been obliterated as the result of folding and metamorphism due to the intrusion of coarse-grained granites along the line of contact with which the cassiterite is found. Quartzites also occur, and present wall-like faces (*e.g.* the eastern face of the Karagwe highlands) which have to be reckoned with in road construction, and thus exercise an influence on the development of the country. The beds dip at high angles and the denuded anticlines form circular or elliptical areas, surrounded by wall-like ridges. The floors of these "arenas" (as they have been termed) are generally occupied by gneiss and granitic rocks, and the known cassiterite deposits occur along the arena walls and in the mountainous country up to 2 miles back from them.

The report describes the several deposits in turn. At Kyerwa, in North-West Karagwe, the ore occurs as grains and lumps occasionally weighing several pounds, in a mass of rough wash and shingle, filling the bottom of a deep, narrow gorge. It seems to have been derived from the weathering of quartz stringers and veins contained in the mica-schists, and from small pegmatitic veins, but has not yet been discovered here *in situ*. In Ibanda, the quartz reefs containing it have been located, as they have been also in the Kikagati area of Southern Ankole, where detrital and alluvial deposits also occur. At present only the alluvial deposits of Kyerwa have actually been worked, 40 tons of tin concentrate having been produced down to the middle of 1926. As the geological conditions in other parts of the country are precisely similar to those of the known tin-bearing area, it is probable that other deposits will be brought to light in time. The report ends with a short discussion of the means of transport and fuel and water supplies. The Kagera river is likely to be of service for one or two of the sites only, and access by road is more or less circuitous.

AMERICA

Two Canadian Place-Names.

Two early Canadian place-names, the origin of which has hitherto been obscure, receive the most plausible explanation yet given in a paper by Dr. W. F. Ganong printed in the volume for 1926 of the *Transactions of the Royal Society of Canada* (Section II. pp. 15–35). The first is the "Bay of Fundy," about which the guesses of former writers have too often been repeated by their successors as established facts. Fundy has been explained either as a corruption of "Fond de la Baie," or as representing the "Rio fondo" (deep river) of some early maps, and while something might possibly be said in favour of the second of these theories, other suggestions have been quite unsupported by facts. Dr. Ganong points out that the early name "Fondo" was never applied to a *bay*, and that the earliest nomenclature of this region was entirely dropped after Champlain's time, "La (grande) Baye Françoise" being then the exclusive name of the bay for three-quarters of a century. After showing that the name as now used makes its first appearance (with variants) about 1680, Dr. Ganong points out that it was at first applied not to the whole bay, but to the Minas basin. Now the entrance to this is marked on the south by a striking narrow cape, of a form which has earned it its present name Cape Split, actually given as Cape Fondu or Funday on various plans and charts of Charles Morris, Surveyor-General of Nova Scotia in the mid-eighteenth century. There can hardly be a doubt, therefore, that Fundy is a corruption of Cap Fendu, the exact equivalent of the English Cape Split.

The second name, Miramichi, is that of a river of New Brunswick flowing into the Gulf of St. Lawrence, and the many explanations given have been entirely speculative. Dr. Ganong traces back the name through an earlier Misamichi (or variants) and to a still earlier Mechemay (or variants) in French maps of the Desceliers group based on Cartier's voyages. This earlier form would be still nearer the later if we suppose that it has lost a terminal syllable -ce, -che, or -chy. And as in some of the earliest maps, it is preceded by "Terre de," we are led to suppose that the name may have been applied to its Indian inhabitants—the Micmacs—by some of their neighbours. It is, in fact, recorded that the Montagnais name applied to them is "Aisimeuts," said to mean "evil people," the full form of the first element being Matshi. In the name Matshimeu Assi, or "Land of the Micmacs," Dr. Ganong finds the most probable origin of the modern Miramichi.

The Volcanoes of Colombia.

Some additions to our knowledge of the great snow-clad volcanoes of the Andes of Colombia, classic ground for the vulcanologist since their first scientific examination by Humboldt, have been made by several travellers during the past few years, and are briefly set forth in the *Zeitschrift für Vulkanologie*, Band 10, Heft 3, 1927. The number opens with an account of a first ascent to the summit of Tolima made by Eugen Krüger of Breslau in March 1918, in company with Herr Schmolinske. This is the highest, perhaps the finest, of the group of four peaks (the others being Ruiz, La Isabel, and Quindiu) which rise from the Cordillera Central in about lat. $4\frac{1}{2}°$ N. lat., and the photographs which accompany the paper give an excellent idea of its character. From the rail-head at Ibague (south-east of the peak) the route led up the valley of the Rio Combeima. Above 2000 metres unbroken forest prevailed to about 3500 metres, the trees being bearded with moss and lichens. The upper limit of forest was at about 3800 metres, above which the tree-like composite *Espeletia grandiflora* characterized the upland grass-steppe. Skirting the eastern and northern sides of the peak the travellers made the final ascent from the west, the snow being reached at about 4900 metres. The summit is formed of a sharp horseshoe-shaped rim open to the north-north-west, and falling steeply inwards, the highest point of all being a pinnacle of bare rock. A longer paper by Immanuel Friedländer of Naples (editor of the *Zeitschrift*) describes his own researches in this region and gives full details of the geology and structure of the volcanoes, with discussion of their past history. He differs from Stübel (whose volcano theory was based on researches in this region) in holding them to be the result of multiple and not simple phases of activity, though he allows that there have been long periods of quiescence. As in other parts of America (and also in Europe) there appear to have been two main periods of activity of very different magnitude, the older being represented by extensive deposits dating back probably to the Eocene and Miocene, while the existing volcanoes are late Tertiary or recent. There have certainly been eruptions during the historical period, one recorded from 1595 being variously assigned to Tolima or Ruiz, which latter was certainly active in the early part of last century. The actual andesite cones are of no great height, the more ancient formations being found in the case of Tolima up to an altitude of 3800 metres, or only 1800 metres below the summit. The outpoured lavas must have been very viscous, for while reaching an imposing thickness they flowed only a short distance and formed bosses or pinnacles above the vents. Previous writers, including Stübel, have considered Tolima to be the most southerly volcano of this group, but a resident at Ibague, Brother Amable (whose map of the district, reproduced with the article, is more accurate than any previously published), has brought to light another, Machin by name, 13 kil. to the south-south-west, the volcanic character of which was fully established by Friedländer. It is much lower (2750 metres) and covered with thick vegetation, so that it is no prominent object. The summit is formed of a few central mounds partly surrounded by a distinct "Somma" wall.

Farther south, in the neighbourhood of Popayan, the Central Cordillera boasts of another group of volcanoes including Sotara, Purace, and Doña Juana, and there are probably others not marked on our maps, the region being still little known. They are of the same type as those previously described —that of bosses extruded from a vent—and are likewise composed of andesite. Of these Friedlander was able to carry out a more or less careful examination

of Doña Juana, while Purace and its neighbourhood are described in a separate (anonymous) article.

POLAR REGIONS

Dr. Lauge Koch's Greenland Expedition.

Further information, which we have received through the courtesy of the Foreign Office, on Dr. Lauge Koch's expedition to Eastern Greenland amplifies the note in the Record last month (p. 319). Dr. Koch made two sledge journeys. Last autumn he went to Mygge bay, where a wireless station is maintained by six young Norwegians. In February this year he left Scoresby Sound accompanied by three Eskimos for Danmarks Havn, which he reached on April 8, returning to Scoresby Sound on June 1. Dr. Koch believes that the sledge route he found running north from Scoresby Sound will be of great value to the settlement there, in regard to the future of which he expresses much optimism. The geological results were valuable; the existence of fossils from the Cambrian, Carboniferous, and Permian periods has been established, and a large number brought back. Dr. Koch returned to Copenhagen on August 20.

HUMAN AND HISTORICAL GEOGRAPHY

Marco Polo and his Family.

We have received through Sir Percy Sykes the reprint of a paper by Prof. G. Orlandini, published last year at Venice in the *Archivio Veneto-Tridentino*, vol. 9, summarizing the results of research on the family history of the great Venetian traveller, and printing, in some cases we believe for the first time, a large number of original documents on which that history is based. While the broad outlines of the story differ but little from those previously laid down, and to be found in Yule's monumental work or in the notes added by Cordier, Prof. Orlandini is able to supply one or two new details, and to give a somewhat new turn to current ideas on the conditions under which the enterprises of the family were carried out. Curiously enough, the particular in which he most definitely corrects or supplements Yule—the maiden name of Marco's wife—is introduced quite incidentally, and it does not appear whether the correct name is now given for the first time. It had been known that her name was Donata, and that she was sister to Agnes Loredano, but whether this latter was a maiden or married name was uncertain. One of the documents printed by Orlandini (No. 9) sets the matter at rest by showing that the maiden name of the sisters was Badoer. Another point now settled is that of the date of Marco's death, which a document now printed (No. 69) shows to have been the very day on which he made his will. The latter in fact bears the actual date 9 January 1324, whereas the death is said to have taken place on the 8th, the discrepancy being probably due to the different way of reckoning the beginning of the day. Regarding the events which led up to the famous travels, Orlandini holds that Marco the elder must have resided at Constantinople a good many years before retiring to Venice, the former city (and later Soldaia, the removal to which, he thinks, was probably made in 1261) being the commercial base, whence the two younger brothers began their eastern travels in the ordinary way of business. He treats as a pure phantasy the notion that on their final return the travellers were regarded as men risen from the dead, holding that the will of Marco the elder (1280) shows that their absence had caused no alarm since the testator showed confidence enough in their return to dispose of his property in their favour. (It should however be remembered that they remained away fifteen years after this.) After their return (in 1295)

the family mansion of "San Gio. Grisostomo," probably acquired by Marco the elder during the absence of his relatives, became the home base whence the elder members, now resting from their more arduous labours, financed the ventures entrusted to the younger generation, though there is now no trace of further operations in the remoter East.

The latter part of the paper treats of the mutual relations of the various members of the family after the return from the East, as displayed by documents relating to the family property, and so on. They concern us chiefly through the sidelight they throw on the character of Marco the traveller, which in Orlandini's view, does not come out as altogether pleasing. His personal relations with the rest of the family seem to indicate a somewhat excessive regard for the interests of his own immediate family, into whose hands the bulk of the property eventually came. His connections by marriage seem also to have been somewhat unduly favoured, and in the end the family home which had once been a bond of union became rather a bone of contention. All this bears out the impression of a somewhat vain-glorious character, conveyed by the travels themselves, though there is no ground for doubting their substantial accuracy.

OBITUARY

Sir Harry H. Johnston, G.C.M.G., K.C.B.

IT is with great regret that we record the death of Sir Harry Johnston, a very old friend of the Society and long a Member of its Council. He was known to all for his explorations and administrative work in Africa during a critical period in the history of the continent. Most, alas! of those most active during that period have now passed away, but we are glad to be able to add to the following summary of Johnston's work, written by one who has consistently followed the course of events in Africa, a personal appreciation by his old friend Sir Alfred Sharpe, who was closely associated with him in Nyasaland during the difficult times preceding and following the declaration of the British Protectorate there. He has written it under the difficult conditions of absence from all books of reference during a cruise abroad.

Sir Harry Johnston, who had been a Fellow of the Society since 1883, a member of Council, and a Vice-President, and who was given the Founder's Medal in 1904 for his explorations and investigations in Africa, died at Woodsetts House, near Worksop, on July 31, in his seventieth year.

Henry Hamilton Johnston, a Scotsman by race, was born at Kennington on 12 June 1858. Educated at Stockwell Grammar School and King's College, London, he studied art for four years at the Royal Academy schools and early showed skill in water colours. He had an early aptitude, too, for natural history and languages. An eight months' visit to Tunisia in his twenty-first year (whither he had gone on account of his health) gave him an intense interest in Africa, which at that time, following Stanley's discovery of the course of the Congo, was on the eve of partition among European Powers. In that "scramble for Africa" Johnston played a part. In 1882 he accompanied Lord Mayo to Southern Angola, and thence, by himself, made his way to the Congo river, where Stanley was then engaged founding the "Free State." Johnston won Stanley's approval, and indeed, at this early age—he was barely twenty-five—Johnston had showed his capacity for leadership. He had won his spurs, and on his return home he was asked by the British Association and

the Royal Society to lead a scientific expedition to Mount Kilimanjaro, while the *Daily Telegraph* commissioned him to act as its correspondent. Johnston went out in 1884, and at Zanzibar placed himself under the direction of Sir John Kirk. Kilimanjaro was partly explored and much useful information obtained. In addition Johnston concluded treaties with the chiefs of Moshi and Taveta, and thus helped in the foundation of British East Africa, though in the result Kilimanjaro itself was included in German East Africa.

In October 1885 Johnston was appointed Vice-Consul for the Cameroons (acquired the year before by Germany) and the Niger Delta (over which a British protectorate had been proclaimed in June 1885). During the three years he spent in the Gulf of Guinea Johnston ascended the Cameroon Mountain and made collections of flora and fauna for the British Museum. He also helped Consul Hewett to set up British administration in the Delta, and increased his reputation as a man specially qualified to deal with Africans. An act on which he set much store was the deposition of the truculent Ja-Ja of Opobo, and the pacification of that region.

Johnston had become acquainted with Cecil Rhodes, who now enlisted him in his schemes for a Cape-to-Cairo "All Red" route, of which Johnston became an advocate as early as 1888. In the spring of 1889—a few months before Rhodes obtained his Charter—Johnston was sent by the Foreign Office to Lisbon to make an agreement as to British and Portuguese spheres of interest in Central Africa. No agreement however was possible then, and as the next move Johnston was sent out as Consul to Portuguese East Africa. He was chiefly concerned with the protection of the small British settlement in Nyasaland, then in conflict with the Arab slavers on Lake Nyasa. The position was complicated by the arrival of a Portuguese force under Major Serpo Pinto, which caused John Buchanan, the Acting-Consul, to proclaim the Shire Highlands a British protectorate. Johnston and his helpers—Mr. (now Sir) Alfred Sharpe, Mr. Alfred Swann, and others—made treaties with a large number of chiefs—treaties which, if honoured in full, would have taken the British flag up to the Victoria Nyanza. As it was, the treaties brought not only the Nyasaland Protectorate as it now is under British control, but also a large area of Northern Rhodesia. Johnston, who became Commissioner of the new protectorate and for four years administered North-Eastern Rhodesia on behalf of Cecil Rhodes, had a good deal of fighting with the Yaos and Angoni before order was established. But when Johnston left Nyasaland in 1897 the pioneer work was practically ended, and an era of development assured. He had suffered from blackwater fever, and was transferred as Consul-General to Tunis, where he spent two happy and fruitful years.

His last official appointment (1899–1901) was as Special Commissioner to Uganda, where he had the task of reorganizing the administration. His settlement of the land question in Buganda has lasted up to to-day. He found time to explore in part the Ruwenzori range and the Semliki Forest, and he secured the first entire skin of the okapi. After his retirement, in 1902, from official duties he took much interest in the affairs of Liberia, which country he visited in 1904 and 1905–6.

This in outline is the story of Johnston's activities in Africa. Of each region he visited he wrote accounts, and he had a happy method of describing the aspect of the land. Besides his natural history studies he gave much attention to the Bantu languages, the result being published (1918–1922) in two large volumes. Of his activities as a politician and his work as novelist it is not here necessary to write. Music was one of his recreations.

Johnston was made C.B. in 1890; promoted K.C.B. in 1896, and was made G.C.M.G. in 1901. He was an honorary D.Sc. of Cambridge; a Gold Medallist of the Zoological Society, and had many other distinctions. He married in 1896 Winifred Irby, daughter of the fifth Lord Boston.

F. R. CANA.

To the account given above of Sir Harry Johnston's work in Nyasaland may be added the following appreciation:

I first met him in 1889 on the Shire River in what is now the British Protectorate of Nyasaland. His official post was then H.M. Consul for Mozambique, but he had been sent by Lord Salisbury on a more or less roving commission to the Shire Highlands and Lake Nyasa to ascertain the exact position as regards British settlers and the missions in the Lake Nyasa regions, and specially concerning the then recent aggressive attitude of the Arab chiefs and slave raiders about the north end of Lake Nyasa. He was authorised to make treaties with any of the powerful native chiefs south and west of Lake Nyasa, and lost no time in visiting these regions. He sent me to the countries west of the lake, and went himself to the north end of Nyasa. The final result of his work in this part of Africa was that the whole of the country between Lake Nyasa on the east and Lakes Bangweulu and Moero on the west came under the British flag: also that portion of the Nyasaland Protectorate which lies south of Lake Nyasa. Under the Anglo-Portuguese Convention of 1891 the protectorate of Nyasaland and the whole of North-Eastern Rhodesia became British.

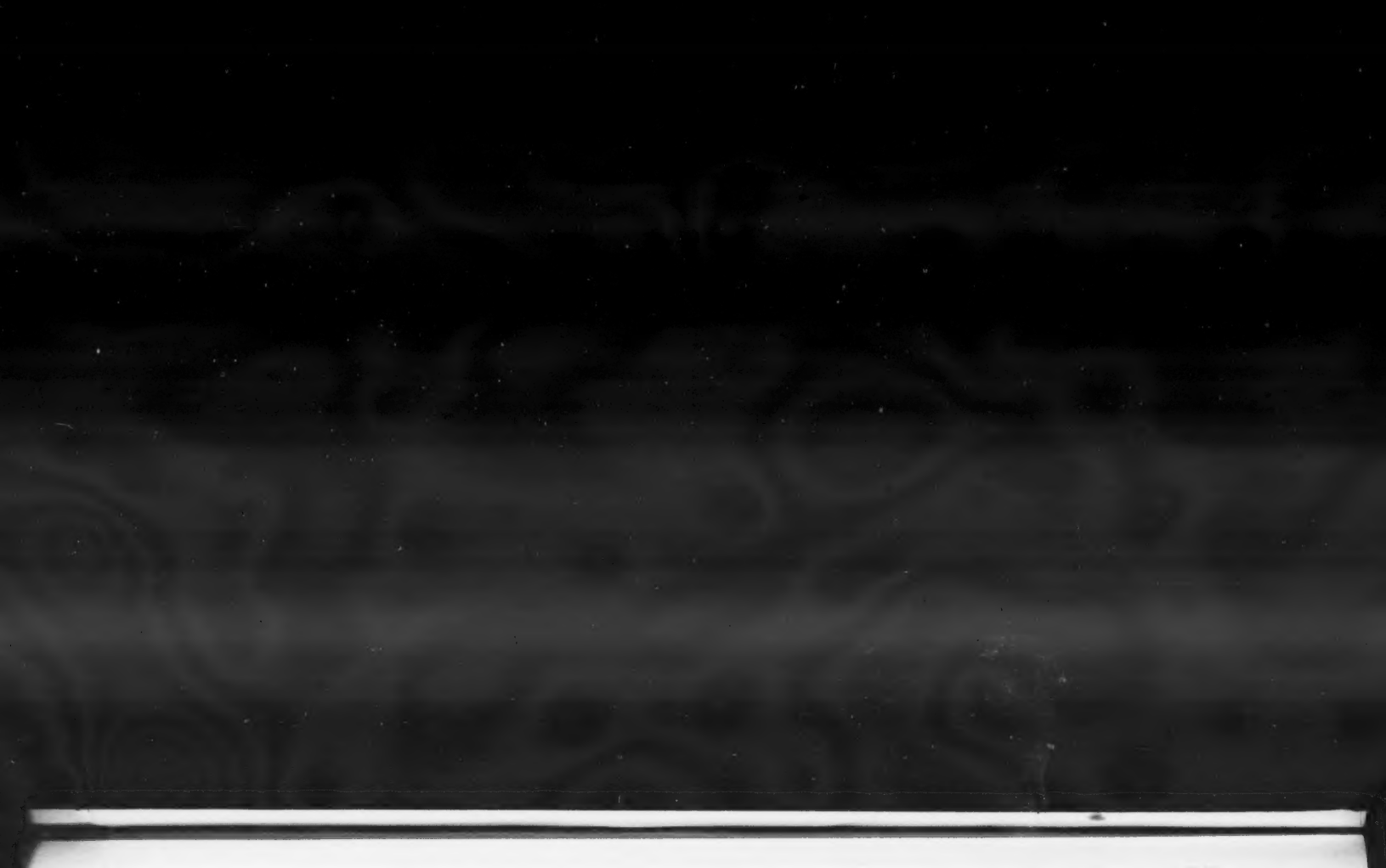
On Sir Harry's first visit to Nyasa in 1889, he patched up a peace with the Arabs north of the lake. On his return to Nyasaland in 1891 as "Commissioner and Consul-General for the Territories under British Influence north of the Zambezi" it was evident that drastic measures were imperative in order to crush the slave trade and oust the slave-raiding Arabs in the North Nyasa districts, and with this object he succeeded in arranging for a contingent of Sikh soldiers from India, with their own officers. A native armed force was also organized, with officers seconded from the British Army.

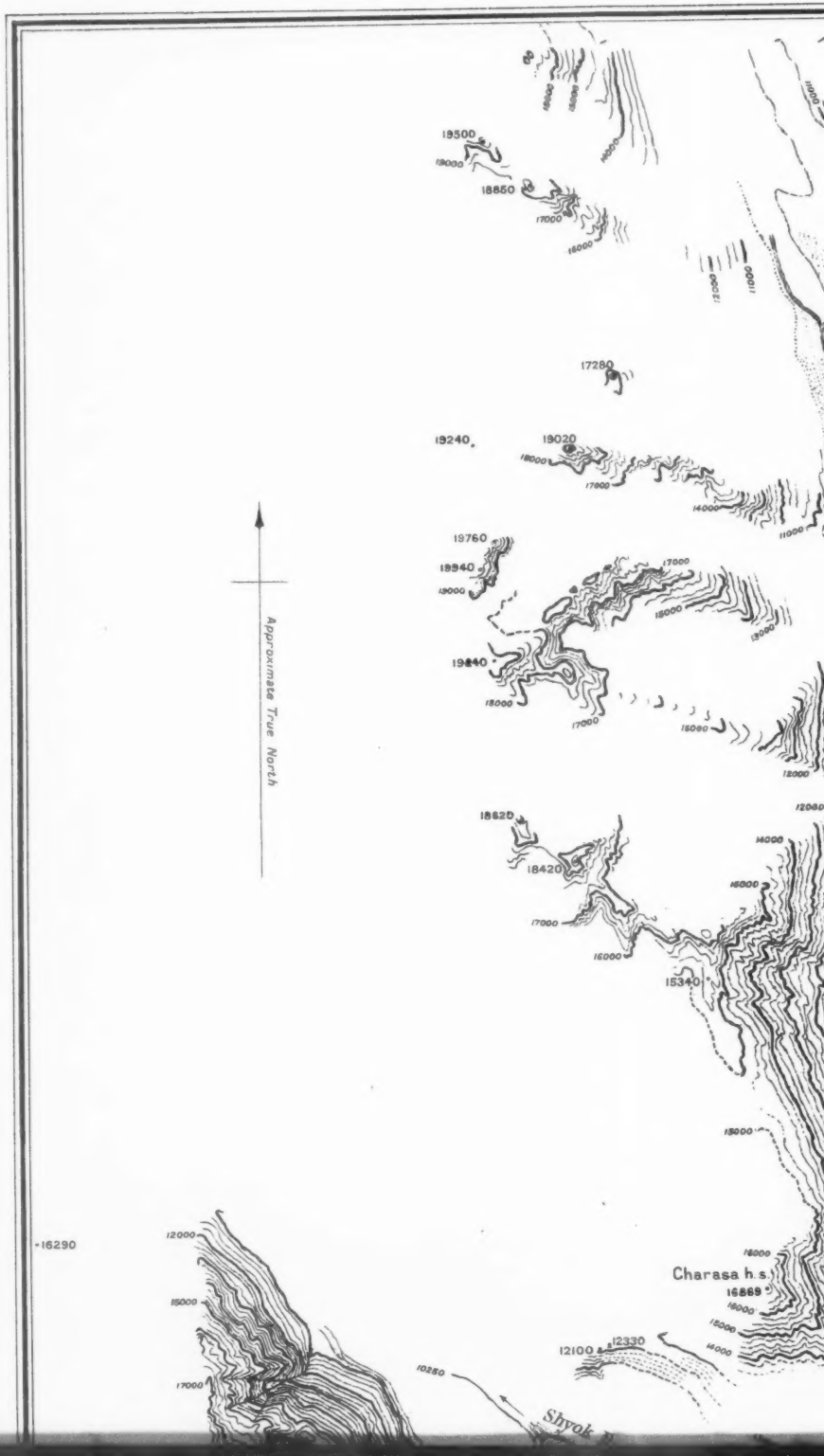
During the early 'nineties Sir Harry had a strenuous time in Nyasaland. After the Arab slavers had been finally crushed, he had to deal with the powerful Ajawa (Yao) chiefs on the south and east coasts of the lake, and it was not till 1895 that we could say all wars and slave raidings were finished.

Johnston was to a great extent enabled to carry out his work in South-Eastern Africa by the generosity of Cecil Rhodes, who practically financed Nyasaland for a year or two in the early times before the Foreign Office had finally adopted us.

I had a great admiration for Johnston. He had great pluck, and though not previously much accustomed to rough and hazardous work, took his full share of hardship and danger on our many military expeditions; and even when fighting was going on kept up his work of painting and writing whenever possible. There has never been a more talented administrator in Africa: a noted painter, writer, botanist, ethnologist, and linguist. He was not happy unless he was working.

ALFRED SHARPE.

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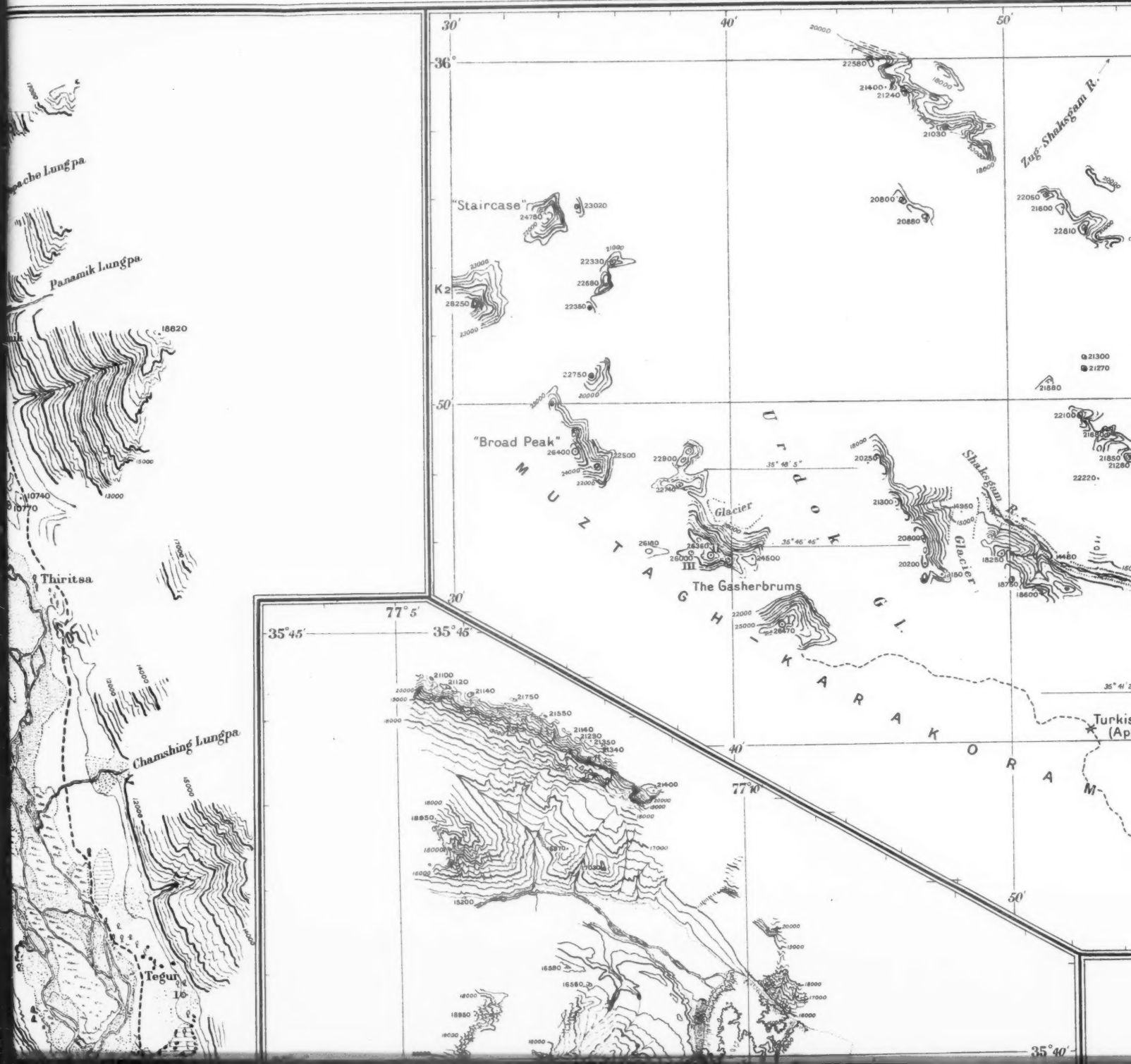
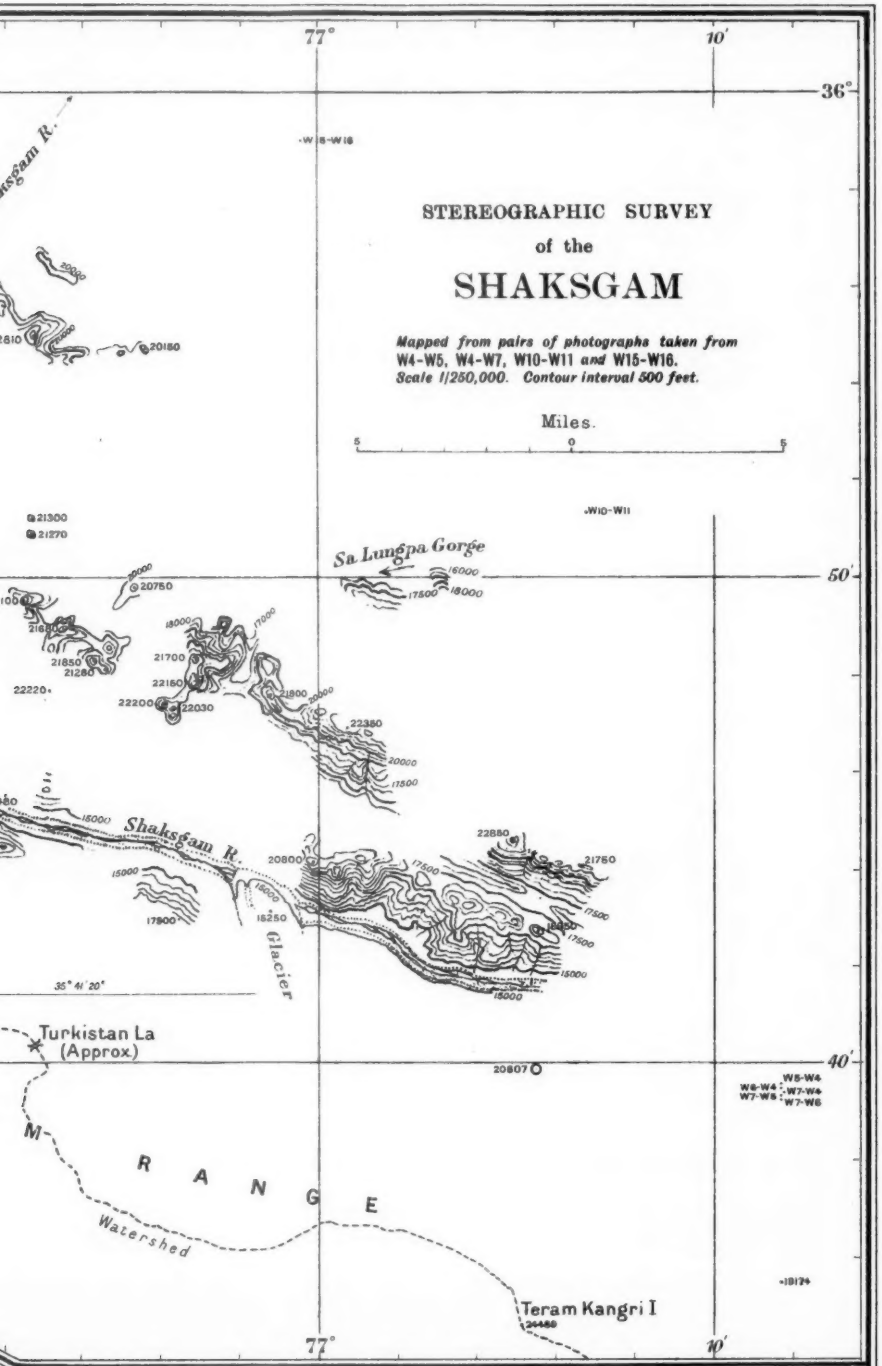
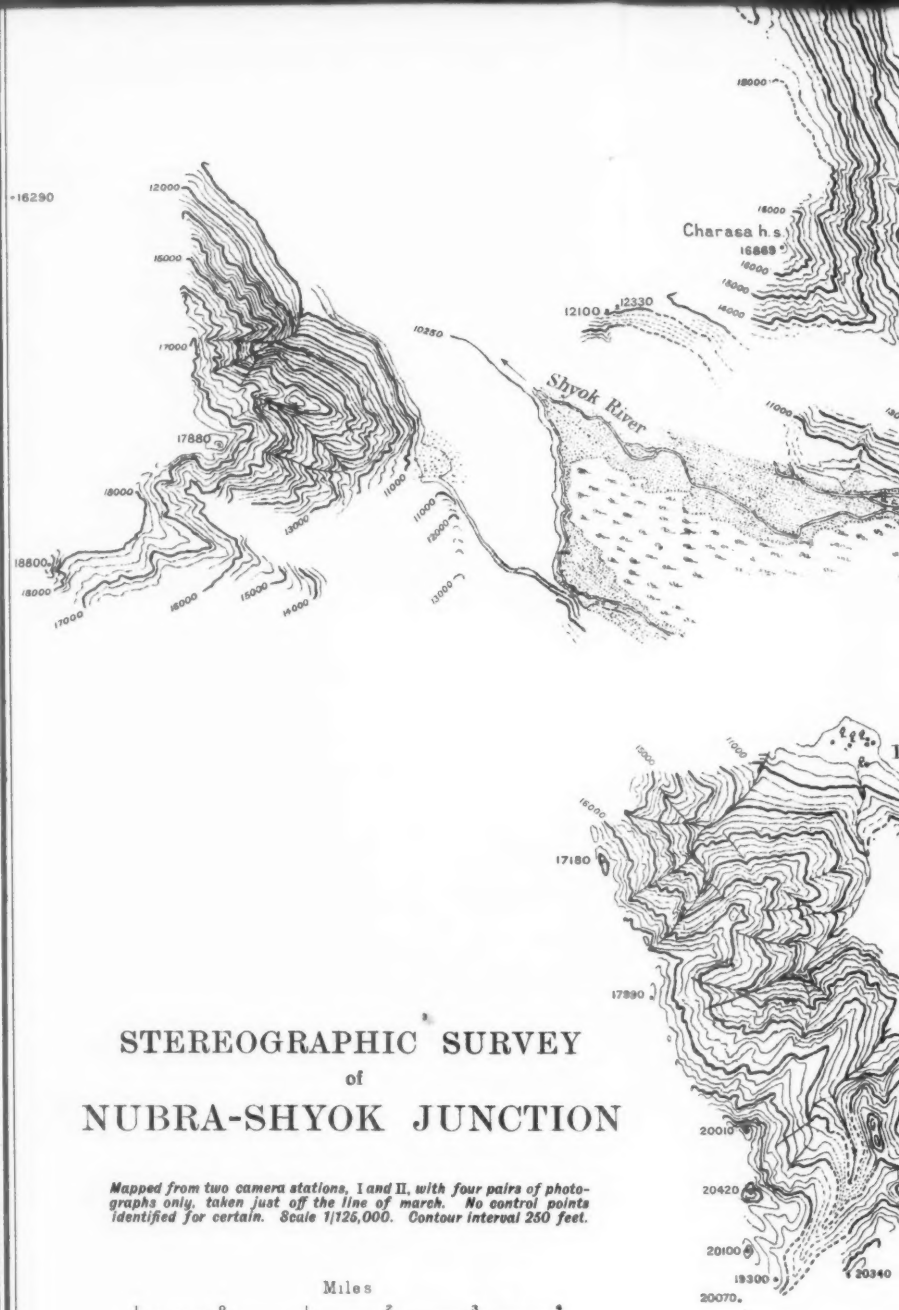
18000
19000
19440
18000
17000
15000
12000
18620
18420
17000
16000
14000
15000
15340
15000
16290
12000
15000
17000
Charasa h.s.
16869
18000
15000
14000
12100
12330
10250
Shyok
Approximate True North

Popa.cho Lungpa
Panamik Lungpa
Panamik
18820
11000
13000
15000
10740
10770
Nubra River
Thiritsa
12000
14000
16000
Chara.sa
Chamshing Lungpa
Tegur
30'
36°
"Staircase"
24750
K2
28250
23000
50'
"Broad Pea
77° 5'
35°45'
35°45'
21100
21120
21140
21750
20000
19000
18000
18950
16000
15200
35°40'


30'
40'
50'
36°
"Staircase"
K2
"Broad Peak"
Urdok
Muztagh
Glacier
Shaksgam R.
Zug Shaksgam R.
The Gasherbrums
Thiritsa
Chamshing Lungpa
Panamik Lungpa
Tegu
77° 5'
35°45'
35° 45'
77°10'
35°40'


77°
10'
36°
W15-W16
STEREOGRAPHIC SURVEY
of the
SHAKSGAM
Mapped from pairs of photographs taken from
W4-W5, W4-W7, W10-W11 and W15-W16.
Scale 1/250,000. Contour interval 500 feet.
Miles.
5
0
5
W10-W11
Sa Lungpa Gorge
50'
Shaksgam R.
Glacier
35° 41' 20"
Turkistan La
(Approx)
40'
M
R A N G E
Watershed
Teram Kangri I
W5-W4
W6-W4 : W7-W4
W7-W5 : W7-W6
77°
10'

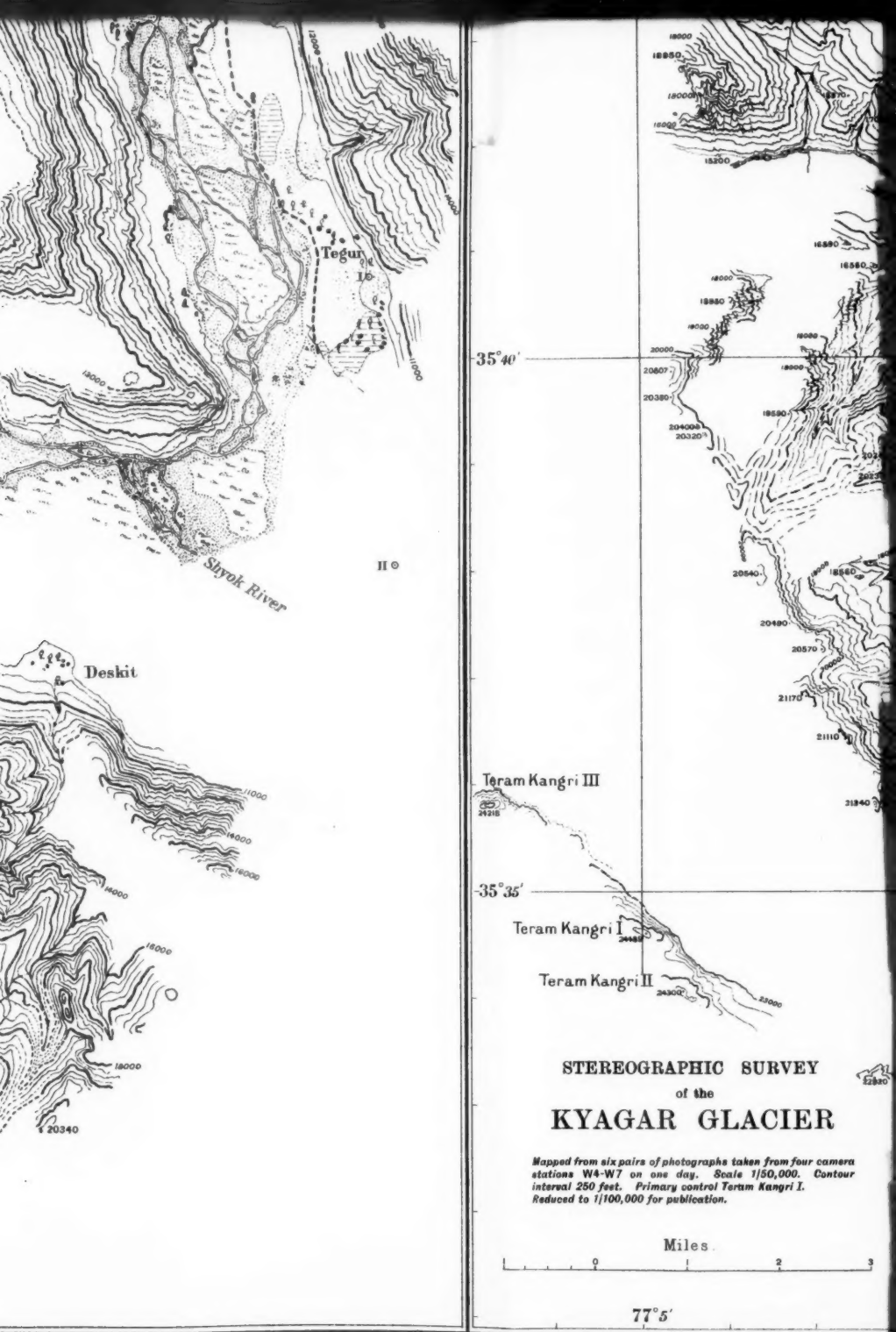


STEREOGRAPHIC SURVEY
of
NUBRA-SHYOK JUNCTION

Mapped from two camera stations, I and II, with four pairs of photographs only, taken just off the line of march. No control points identified for certain. Scale 1/126,000. Contour interval 250 feet.

Miles

0 1 2 3



STEREOGRAPHIC SURVEY

of the

KYAGAR GLACIER

Mapped from six pairs of photographs taken from four camera stations W4-W7 on one day. Scale 1/50,000. Contour interval 250 feet. Primary control Teram Kangri I. Reduced to 1/100,000 for publication.

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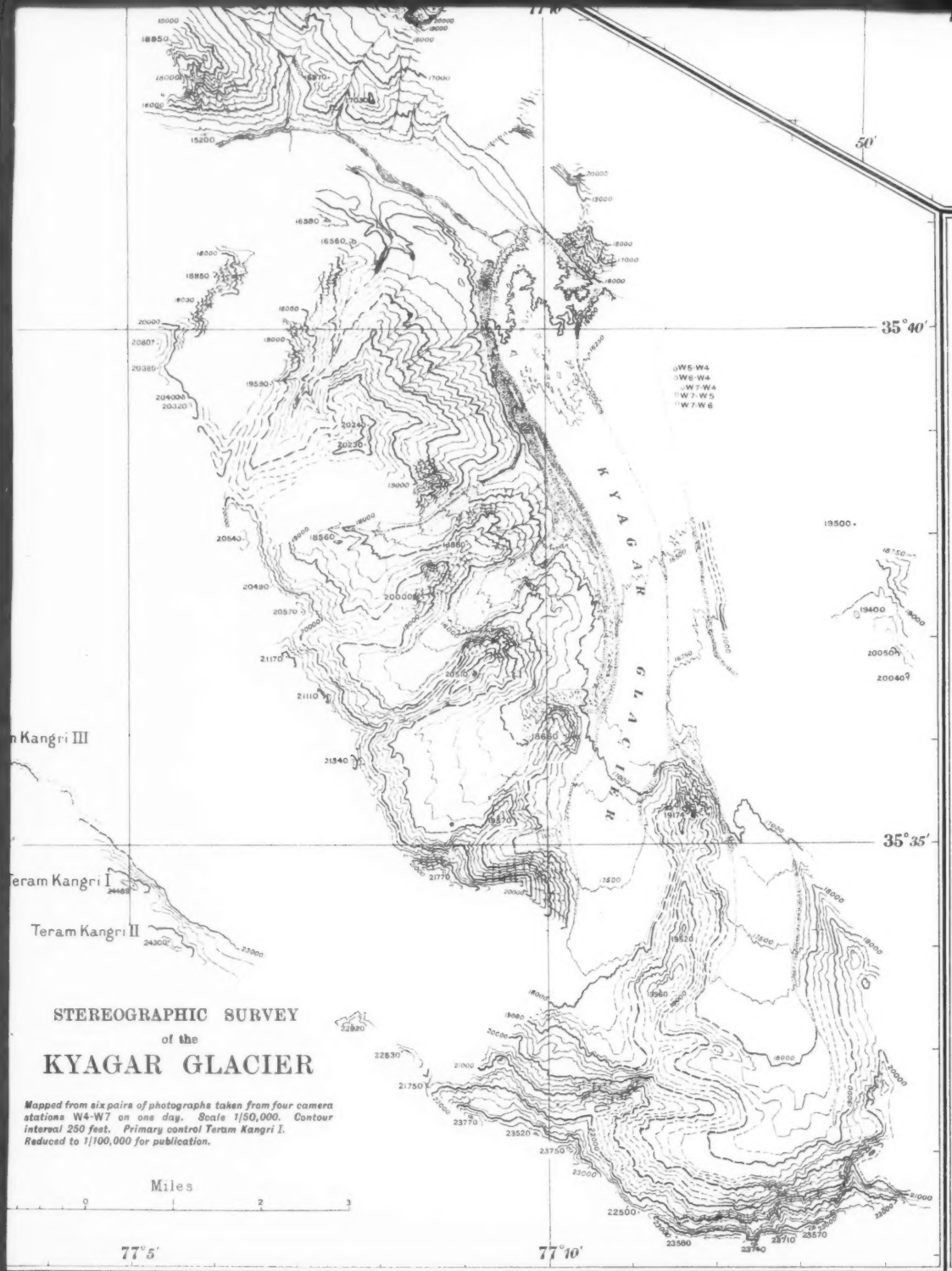

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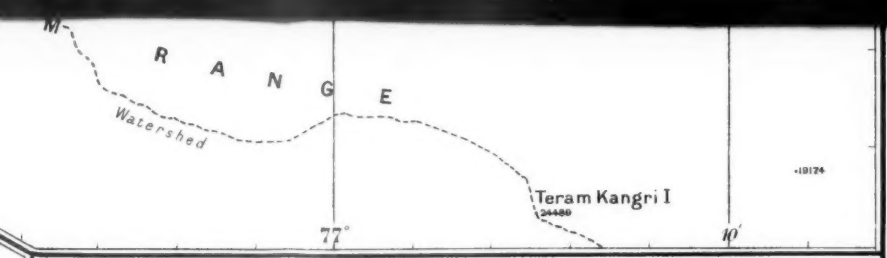


STEREOGRAPHIC SURVEY

OF THE

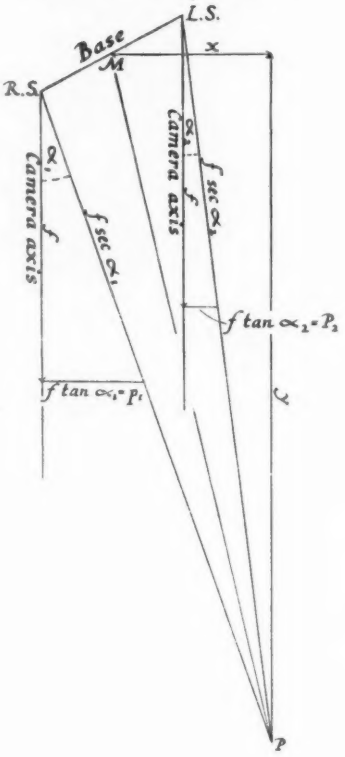
SHAKSGAM

with the Photo-Theodolite and
Autograph of Mr. Henry Wild

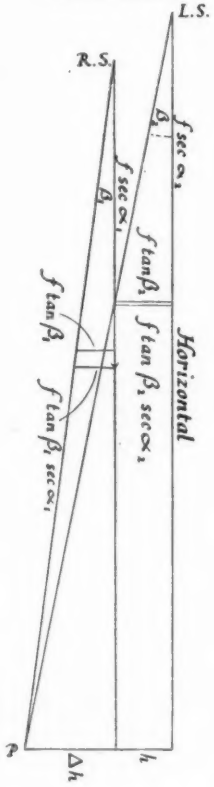
by

MAJOR KENNETH MASON, M.C., R.E.
Survey of India

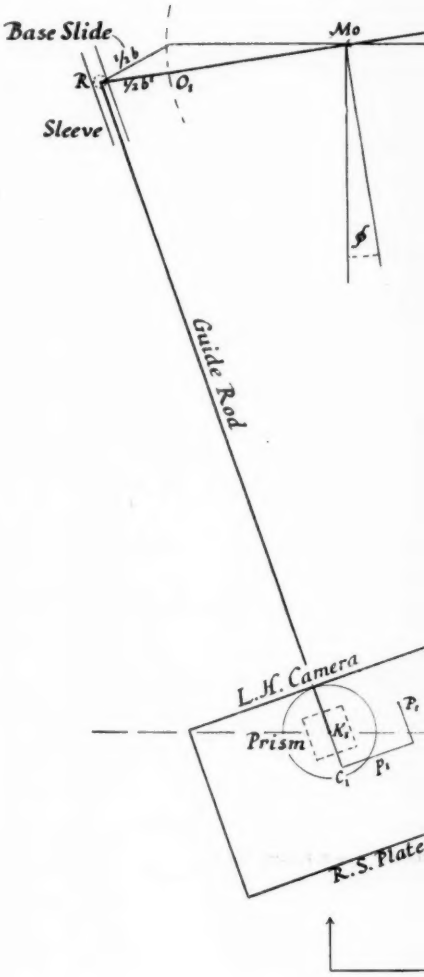
Field Plan 1/40,000



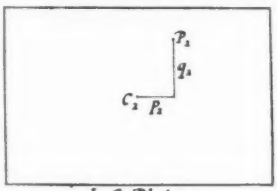
Field Sections



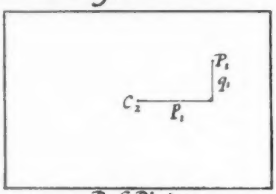
Autograph Pl



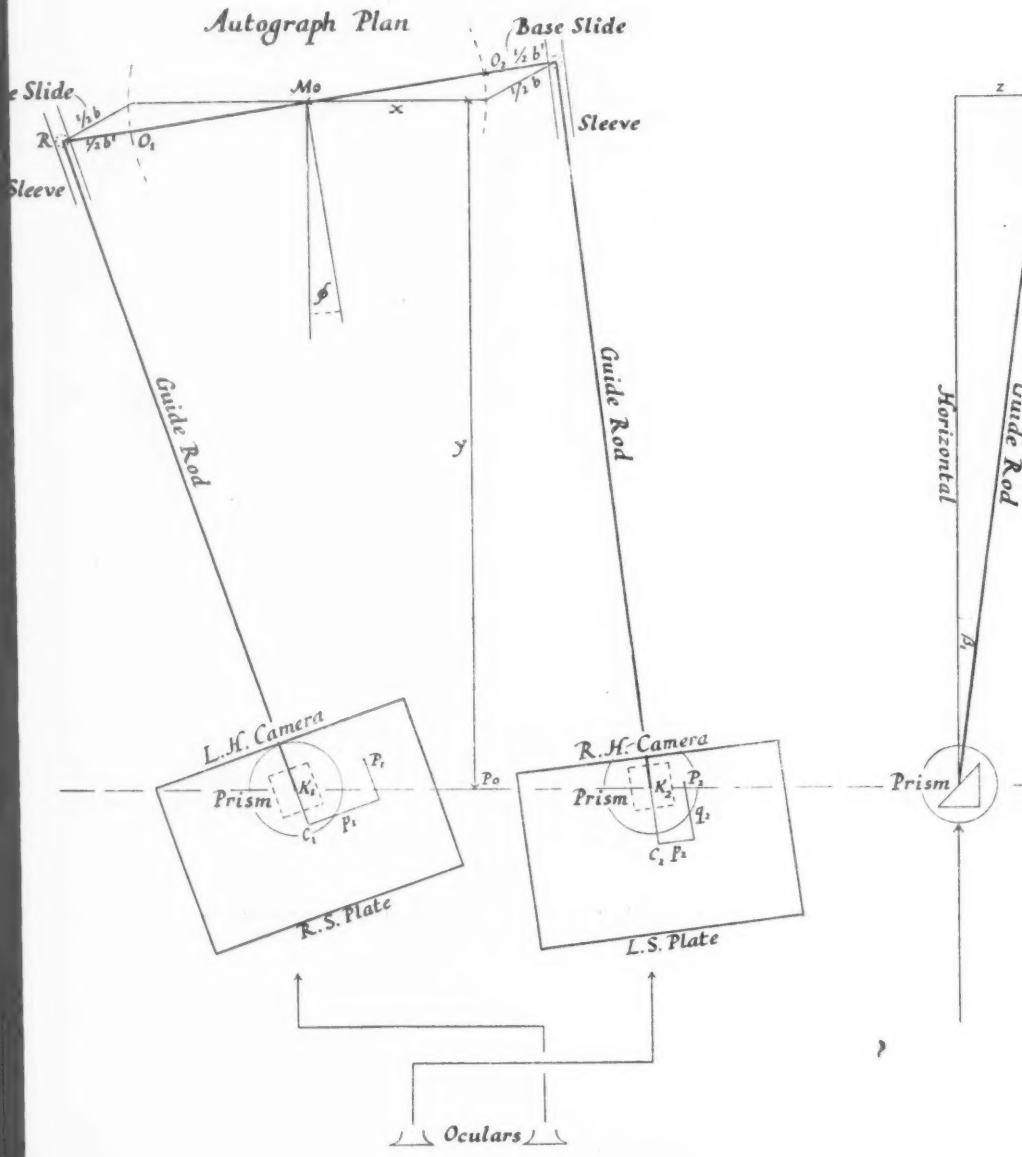
Plates as in Field Camera seen from back.

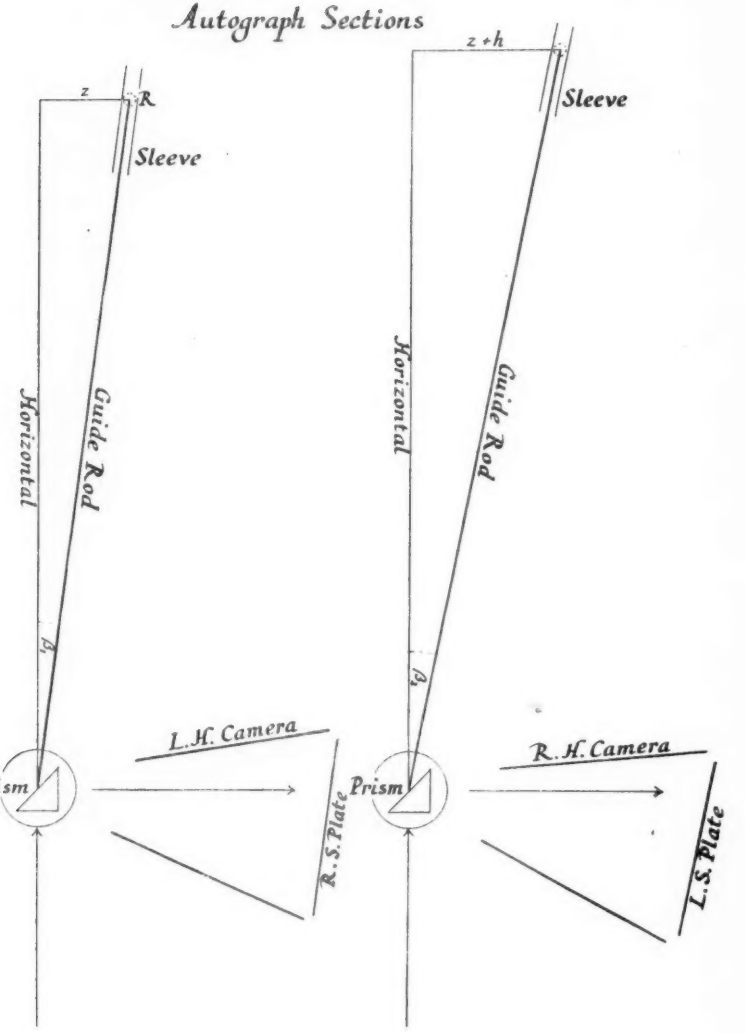


L.S. Plate

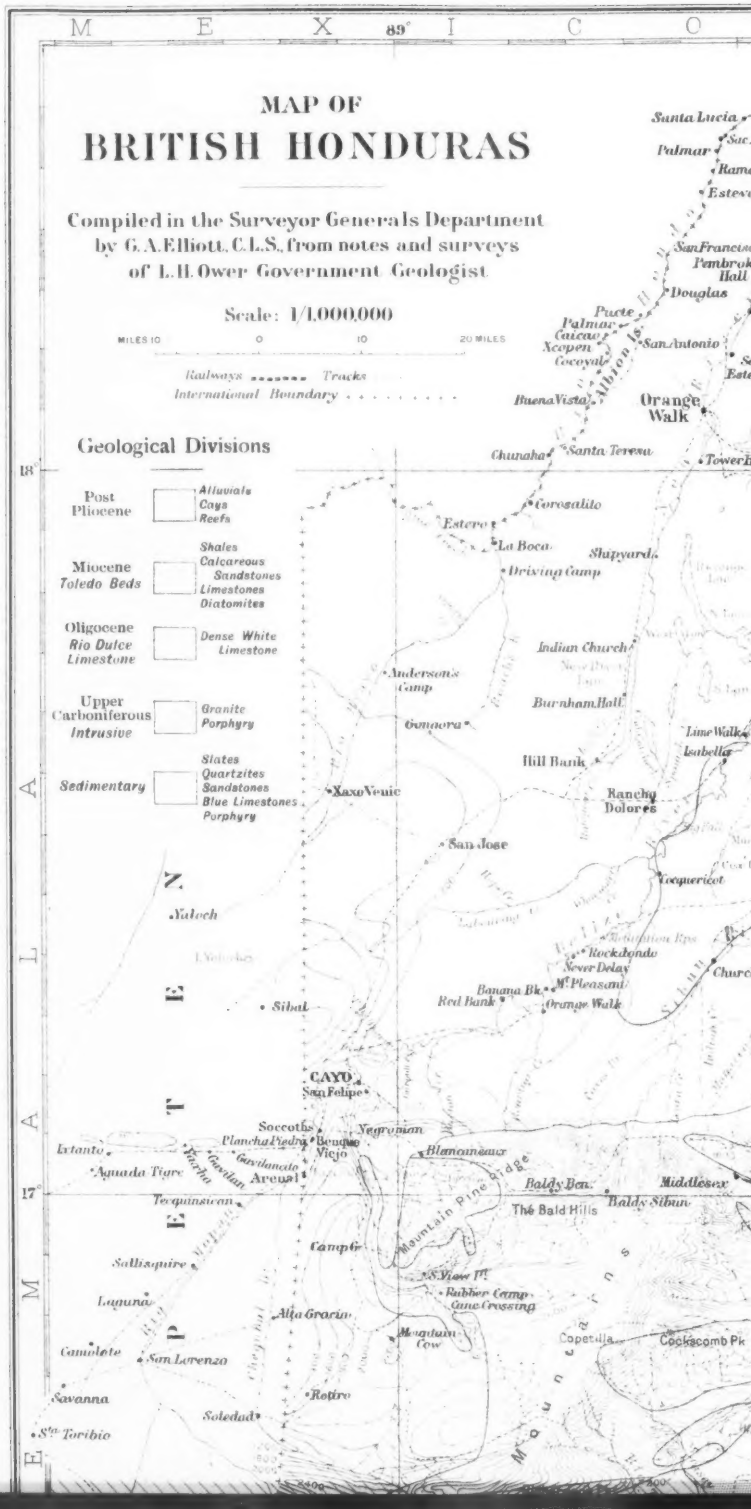


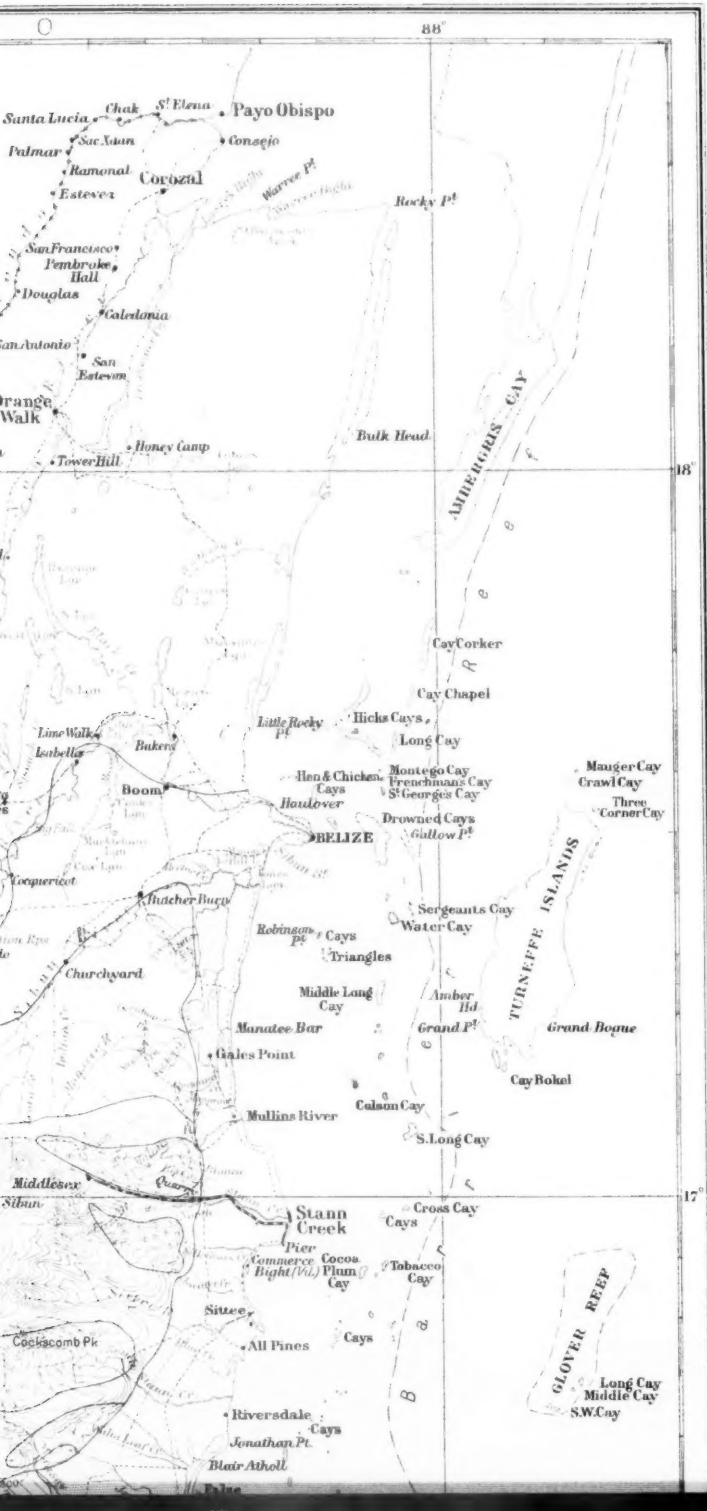
R.S. Plate

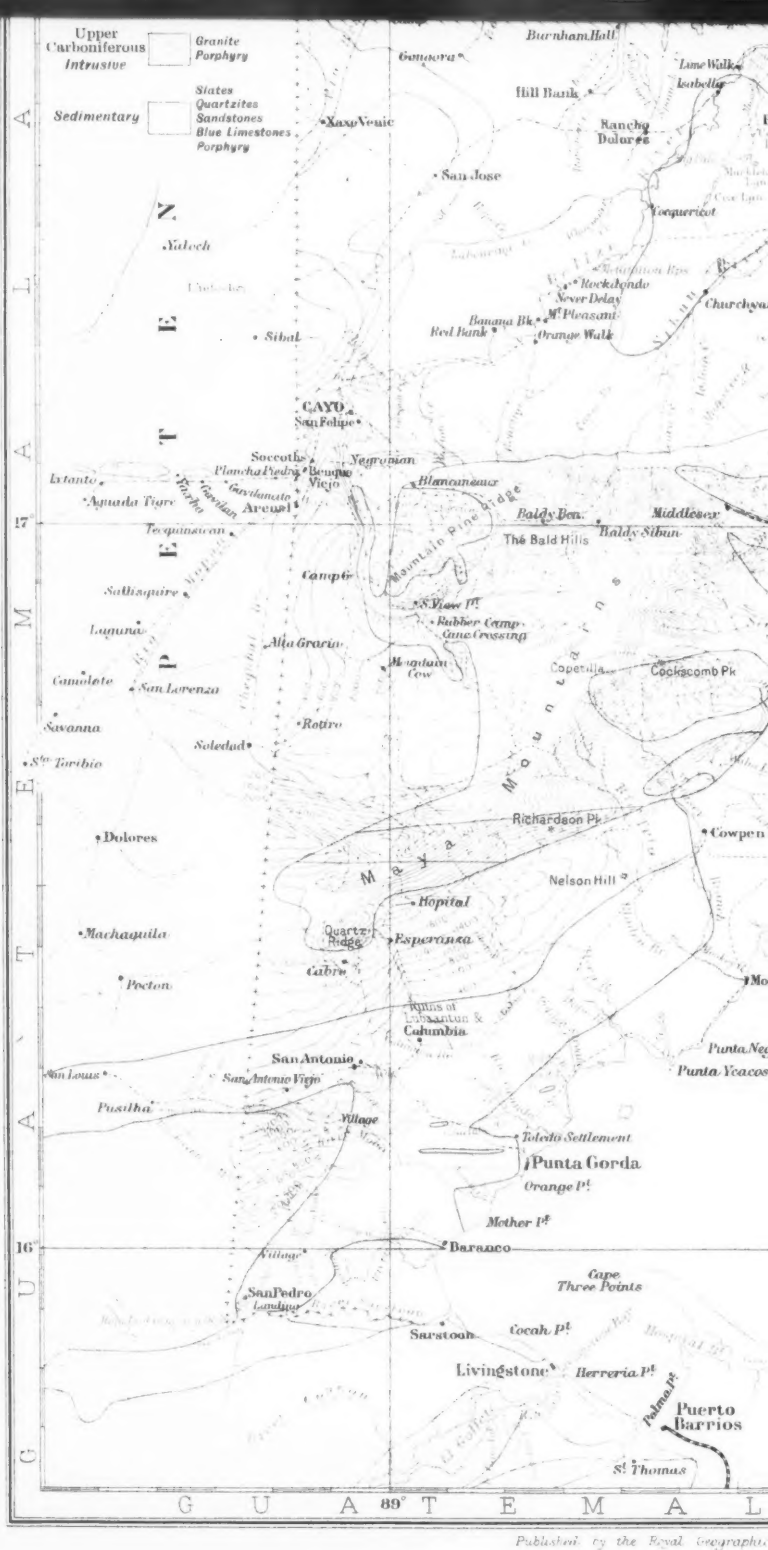

Autograph Plan
Base Slide
Sleeve
Sleeve
Guide Rod
Guide Rod
Horizontal
Prism
L.H. Camera
R.H. Camera
Prism
Prism
R.S. Plate
L.S. Plate
Oculars



HINKS
THE AUTOGRAPH


MEXICO
89°
MAP OF
BRITISH HONDURAS
Compiled in the Surveyor Generals Department
by G. A. Elliott, C.L.S. from notes and surveys
of L. H. Ower Government Geologist
Scale: 1/1,000,000
MILES 10 0 10 20 MILES
Railways
Tracks
International Boundary
Geological Divisions
Post Pliocene
Alluvials
Cays
Reefs
Miocene
Toledo Beds
Shales
Calcareous Sandstones
Limestones
Diatomites
Oligocene
Rio Dulce Limestone
Dense White Limestone
Upper Carboniferous
Intrusive
Granite
Porphyry
Sedimentary
Slates
Quartzites
Sandstones
Blue Limestones
Porphyry
GUATEMALA
18°
17°
Santa Lucia
Palmar
Douglas
Pucte
Palmar
Caicaw
Xcopen
Cocoyal
San Antonio
Albion Is.
Buena Vista
Orange Walk
Chunaha
Santa Teresa
Corozalito
Estero
La Boca
Shipyard
Driving Camp
Indian Church
Anderson's Camp
Burnham Hall
Gomora
Hill Bank
Xaxo Venic
Rancho Dolores
San Jose
Yalock
Sibal
Rockdale
Never Delay
Mt Pleasant
Banana Bk
Red Bank
Orange Walk
CAYO
San Felipe
Socotha
Negroman
Benque Viejo
Blancaneaux
Baldy Bon.
Middlesex
Baldy Sibun
The Bald Hills
Mountain Pine Ridge
Camp G
Rubber Camp
Cane Crossing
Alta Gracia
Cockscomb Pk
San Lorenzo
Retiro
Soledad
Savanna
Sta Toribio
Mountains


88°
18°
17°
Santa Lucia
Chak
St Elena
Payo Obispo
Sac Xaan
Consejo
Palmar
Ramonal
Corozal
Estevez
Warree Pt
Rocky Pt
San Francisco
Pembroke Hall
Douglas
Caledonia
San Antonio
San Estevan
Orange Walk
Honey Camp
Bulk Head
Tower Hill
AMBERGRIS CAY
Cay Corker
Cay Chapel
Little Rocky Pt
Hicks Cays
Long Cay
Lime Walk
Isabella
Bakers
Hen & Chicken Cays
Montego Cay
Frenchmans Cay
St Georges Cay
Mauger Cay
Crawl Cay
Three Corner Cay
Boom
Haulover
Drowned Cays
Gallow Pt
BELIZE
Tocqueriot
Thatcher Burn
Sergeants Cay
Water Cay
Robinson Pt
Cays
Triangles
TURNEFFE ISLANDS
Churchyard
Middle Long Cay
Amber Hd
Manatee Bar
Grand Pt
Grand Bogue
Gales Point
Cay Bokel
Calson Cay
Mullins River
S. Long Cay
Middlesex
Silbun
Stann Creek
Cross Cay
Cays
Pier
Commerce Bight (Vil.)
Cocos Plum Cay
Tobacco Cay
Sittee
Cays
All Pines
Cockscomb Pk
GLOVER REEF
Long Cay
Middle Cay
S.W. Cay
Riversdale
Cays
Jonathan Pt
Blair Atholl
Palma



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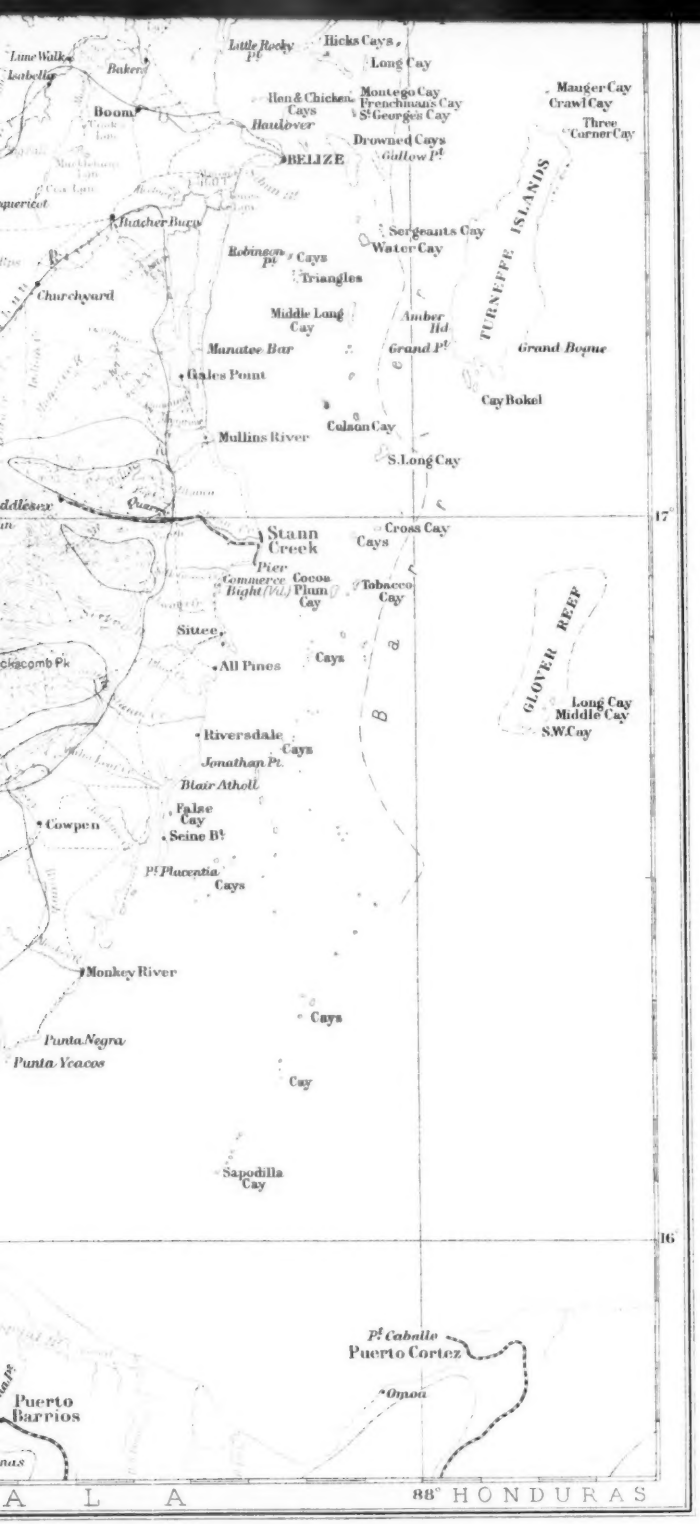

Royal Geographical Society

BRITISH HONDURAS

Ower.